EXTRACTION OF BLUE PINE AND FIR BEAMS FROM KULU FORESTS.

Fig. 1.

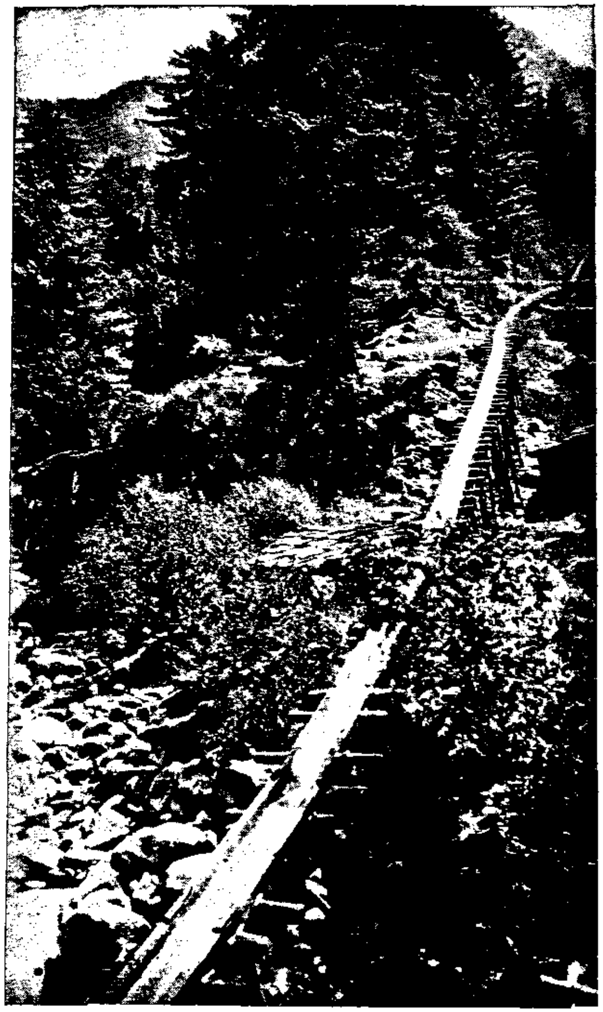

Photo.-Mechl. Dept., Thomason College, Roorkee.

Wet slide working. Note sleeper coming down.

Fig. 2.

Sleepers nearing end of slide and about to fall into pool.

VOLUME XLIII NUMBER 1

INDIAN FORESTER

JANUARY, 1917.

EXTRACTION OF BLUE PINE AND FIR BEAMS FROM KULU FORESTS.

BY C. G. TREVOR, I.F.S.

The accompanying plates (Plates 1 to 3) show the nature of the work being carried out and the method of extraction. These forests ascend to 9,000 feet and consist of a mixture of blue pine (*Pinus excelsa*), spruce (*Picea morinda*) and silver fir (*Abies Webbiana*). They are of very fine quality, and are being worked on the shelter wood compartment system, and regeneration fellings are now in progress. The object of management is to obtain a mixture of all three species, fairly rich in Kail, on the warmer aspects. It is not intended to deal with the silviculture of these forests here, as it is being dealt with in another paper. Small scantlings, such as the 10-foot B. G. sleeper, do not pay, as there is no demand; but big beams command very fair prices in the plains, and the maximum size now being exported is 15′ × 12″ × 6″. Such a large beam cannot be carried, and dragging by coolies is a most unsatisfactory method of extraction, so that it is necessary to take these slides as high up into the forest as possible. The slide is erected on

poles supporting the rough-axed sleepers on which the slide-way rests; the slide itself consists of 1 beam and 1 'bala' (or small scantling) on the bottom and a beam along each side, the joins are rammed with moss and the whole braced by driving wooden wedges between the side beams and the supporting sleeper. The slide shown has been erected and photographs taken by Mr. H. W. Bicknell, the Manager of Messrs. Spedding & Co., the lessees of these forests. The construction of the slide is clearly shown in the plates and also the pools which have to be made at intervals in order to maintain the water-supply. The method of floating by kutcha chutes is also shown. At the conclusion of the work the whole slide is dismantled from the top and the component scantlings sent down to the river. The cost of such a slide is about Rs. 1,000 a mile, and when a large quantity of timber has to be extracted this arrangement saves both time and money and indeed is the only practical way to work the high-lying fir forests which so far have been left untouched.

FUEL AND BAMBOO PLANTATIONS IN THE SITTANG DELTA OF THE PEGU DISTRICT, LOWER BURMA.

BY J. M. D. MACKENZIE, I.F.S.

During recent years, in the paddy districts of Lower Burma, the price of timber, fuel and bamboos has increased, and the supply decreased, to such an extent that the matter has become one for serious consideration, as it seems probable that the enhanced cost of living will react upon the rates of land and other revenue. It has been proposed that each village, or group of villages, should have its own fuel and bamboo plantation; since the Kamase reserve was made in 1898, various attempts have been made to plant it up, and the history of these may be of interest in connection with this scheme.

The proposals referred to above were shortly as follows:—In every area, there is some paddy land, very much worse than others, which can hardly be made to pay because it is either too low, or too high. That part which is too high for successful cultivation

EXTRACTION OF BLUE PINE AND FIR BEAMS FROM KULU FORESTS.

Fig. 3.

Photo,-Mechl. Dept., Thomason College, Roorkee.

The slide ending in a pool whence ordinary floating by "chute" is being done.

Fig. 4.

A sleeper "chute".

Fig. 5.

A sleeper "chute" used for floating down small streams.

Fig. 6.

(and therefore not regularly flooded) would be the best for growing trees or bamboos, and would be planted up with them, one or more such plantation being made for each village or group of villages, so that nobody need go more than, say, five miles for his supply. The plantations would be under the general supervision of the Forest Department, but villagers would do necessary work (boundary repairs, etc.,) themselves and the cost would be nil. If costs were incurred they could be recovered by a small duty, but this should be avoided if possible. In some cases, at least, it is hoped that private individuals will take the matter up, and plant their worst paddy land with bamboos for sale. But the Burman is very conservative in such matters and it is for the Forest Department to show that profits can be made by this treatment; when fully satisfied that there is no catch, others may follow our example, and use the information got together.

The Kamase reserve was notified in 1898 and very little was done to it until 1901-02.

It contained no trees, and very little scrub jungle at this time, the D. F. O. remarking that it was "like a billiard table."

The ground was covered with thatching grass (*thetke*), and it was only used for this and grazing purposes. The reserve is situated some 16 miles south-east of Pegu, close to the Sittang river, accretions from which form the land. West of the reserve for many miles nothing but paddy land occurs, the country being almost flat (varying only by about three feet), and being inundated to a depth of 2 or 3 feet every year, from June to October, partly by rain and partly by the overflow of the Sittang river. This brings a rich deposit of silt, which forms the finest paddy land in Burma. Consequently all tree-growth—if there ever was any—has been destroyed to make room for paddy. So we have a reserve of 9 square miles, situated on magnificent paddy land, right in the middle of one of the best paddy districts in Burma, and producing only a few annas per acre per annum for grazing and *thetke*. The reason for reservation was, in the first instance, to establish a belt of forest to prevent fertile lands being covered by sand blown from the sea-shore. This danger no longer

exists. They have nothing to do with the matter under discussion. The local Burman hates the reserve, as it prevents his getting more paddy land and he by no means considers the reserve to be "sour grapes." Consequently on several occasions attempts have been made to get it disforested; that made in 1914-15 is still under consideration by the Government.

About 1900, orders were light-heartedly given that the area should be reafforested. The fuel question was then becoming acute, and it was thought that this reserve might be partly able to supply the want. At the present time, this want of fuel is becoming more and more serious. Villagers either have to get their supply by carts and boats from the other side of the Sittang river, or in carts from unclassed forests 10 or 20 miles north of Pegu—a distance of 25—35 miles from their villages. The price of fuel imported by water is almost prohibitive (it is estimated at Rs. 100 to Rs. 150 per annum for the ordinary cooly family) while the time occupied in cutting and conveying it from the forests beyond Pegu makes it very hard for a man to obtain his supplies; the roads are only open from the middle of January to the middle of May, and he has to cart his paddy, up till the middle of March, which leaves him at the most two months to cut fuel and cart it 35 miles, besides any materials he wants for houses, sheds, etc. Consequently the price of fuel in parts of the delta is as high as Rs. 25 to Rs. 30 per ton of 50 cubic feet. The Burman will not use dried cow-dung cakes, so this offers no solution.

Bamboos are another absolute necessity, the price of which is very high. All houses are built of bamboo and *thetke, salu* (Licuala peltata) or *dani* (Nipa fruticans).

Bamboo prices are as follows:—

Tinwa (*Cephalostachyum pergracile*) Rs. 8 to Rs. 12 per 100
Kyathaungwa (*Bambusa polymorpha*) „ 18 „ „ 30 „ „
Wanet (*Dendrocalamus longispathus*) up to As. 8 per culm (green).
Waya (*Oxytenanthera nigrociliata*) As. 4 to As. 5 per culm (green).
Wapyu (*Dendrocalamus membranaceus*). Rs. 7-8 to Rs. 10 per 100

The bamboos have to be brought from long distances, some coming from as far off as Prome, on the Irrawaddy. A large part of the expense of both fuel and bamboos is cart-hire, which could be cut out if supplies could be obtained at reasonable distances. It amounts to annas 4 per 100 per mile for small, and annas 8 per 100 per mile for big bamboos. Hence some method of utilizing the worst class of paddy land seems indicated. This land only pays a very small revenue to Government (Re. 1 to Rs. 2 per acre per annum) and gives very small profits to the cultivators.

Previous Planting Operations.

In 1901-02 several carts of seeds of various kinds were put down haphazard.

In 1902-03 seeds of various kinds were put down, which germinated, but were eaten by cattle. Some dibblings were tried; nurseries were started, and the plants put out on mounds. None of these operations were successful, owing to excessive grazing which was entirely prohibited by the Government in 1903. Nothing was done in 1903-04-05, but about 50 cutch plants were found living from planting, which were, however, attacked by a weevil and all killed.

In 1905-06 a quantity of seeds of various kinds were sown in nurseries, and the resulting seedlings put out when a few inches high; this was another failure.

In this year, a new experiment was tried: a few people were allowed to plant plantains, and in between each pair of plantains trees of various kinds were planted on mounds.

In 1907-08 nothing new was done, and in 1908-09 only three old plantain cultivators were left. Parallel dikes three feet high were made for the plantains, and trees planted between them on mounds. Rats were said to damage the young trees, especially cutch.

In 1909-10 areas were restricted and rules laid down, but the same general scheme was carried on up till 1912-13. It is the only scheme which seems to promise any success and a modification of it is to be tried further.

In 1914-15, and 1915-16, the following scheme was attempted. Bunds were made nine feet apart, with trees and plantains on them alternately, paddy being cultivated between the bunds. This was an entire failure, as the water killed off both the plantains and the trees. The paddy, however, did very well, which was what the cultivators wanted.

The scheme adopted this year (1916-17) is more or less of a combination of the last two. Trees were planted on ridges, alternately with plantains, no paddy being allowed in this area. In return for planting trees, the men are allowed to plant paddy, in a different part of the reserve. The cost of tree planting is recovered by the sale of plantains, so that planters incur no actual expense. If they did so the profits from the paddy land, even after paying Rs. 4 per acre land revenue, would amply repay them.

The trees which have been found to be most successful up to date are :—

(1)	Thinbaw kokko	(*Enterolobium Saman*).
(2)	Kathit	(*Erythrina arborescens*, var. *indica*.)
(3)	Sissoo	(*Dalbergia Sissoo*).
(4)	Sit	(*Albizzia procera*).
(5)	Mango	(*Mangifera indica*).
(6)	Nyaung	(*Ficus* spp.).
(7)	Thabye	(*Eugenia Jambos*).
(8)	Letpan	(*Bombax malabaricum*).
(9)	Pyinma	(*Lagerstrœmia Flos-Reginæ*).
(10)	Cutch	(*Acacia Catechu*).
(11)	Bambwe	(*Careya arborea*).
(12)	Kyi	(*Barringtonia acutangula*).

Of these *E. Saman*, *Erythrina* sp., *Ficus* sp., and *B. malabaricum* are practically useless for fuel. Of the remainder the best are perhaps *D. Sissoo*, *Eugenia Jambos* and *L. Flos-Reginæ*, closely followed by *M. indica*.

Cutch and *bambwe* are attacked, the former by rats and the latter by a caterpillar. *Sit* and *kyi* neither do very well, nor produce really good fuel.

The reasons that the list gives trees of somewhat mixed kinds are that parts of the area are salt, and in the rains the area is mostly under water, while in the dry weather it is waterless.

This year, *Pterospermum* sp. and mulberry (*Morus indica*) have been tried : the result is not yet apparent.

The essentials for trees to grow in this area are that they must be able to stand submersion, off and on, for six months, followed by six months of drought; that they should be good fuel species; and, if possible, that they shall coppice well.

D. Sissoo, *E. Jambos*, and *L. Flos-Reginæ* apparently fulfil the first of these conditions, and are believed to be likely to fulfil the second and third : mangoes also appear to do well ; and in this case, early returns from fruit (at 8 to 10 years) should considerably help out the final financial results. *Bombax malabaricum*, and *E. Saman* both do very well indeed, but are locally considered to be almost useless for fuel ; in the case of the latter, I believe that this is due to the difficulty of splitting it.

As regards bamboos, little has been done yet.

Wanet (*Dendrocalamus longispathus*), Wapyugyi (*Gigantochloa macrostachya*) and Wapyugale (*Bambusa Oliveriana*) are found growing in villages, and will therefore probably do well; but root-stocks are not easy to get. Kyathaungwa (*Bambusa polymorpha*) was planted this year, and about 25 per cent. have established themselves. The failure of the remainder is believed to be due to the age of the culms. It is proposed to try ten acres of each of the bamboos mentioned, together with Tinwa (*Cephalostachyum pergracile*), Wanwe or Wagank (*Oxytenanthera albociliata*), Waya (*Dendrocalamus longispathus*), Wabo (*Bambusa gigantea*), Thaikwa (*B. longispiculata* or *Tulda*).

To take the cheapest bamboo only (Wapyu), some 300 clumps can be planted per acre. It is estimated that these will take seven years to establish themselves, yielding one culm per clump in the fifth and sixth years. In the seventh year each clump should yield three culms. That is 900 culms per acre. The price of these at a village on the boundary of the reserve is Rs. 7 to Rs. 9 per hundred, which gives a money yield of from Rs. 70 to Rs. 90 per acre per annum after seven years. Cutting costs only Re. 1-8 to

Rs. 2 per hundred; therefore, at present price, each acre of Wapyu should yield a clear profit of Rs. 50 to Rs. 70 per acre per annum after the first six years; Wanet is sold at as much as annas 8 per culm. Allowing for a considerable fall in price, 900 culms at annas 4 per culm gives a yield of Rs. 225 per acre per annum or Rs. 200 clear profit. This figure also holds good for the larger bamboos (Wabo and Kyathaungwa). As they would only be grown on the worst paddy land, yielding a doubtful profit of Rs. 10 to Rs. 15 per acre under paddy, it is hoped that private persons will take the matter up, if it can be proved feasible. The great deterrent to the average Burman is, firstly, the initial wait of five or six years; and, secondly, the chance of the bamboo flowering. The initial cost is also somewhat high, about Rs. 50 per acre, (against which, however, is to be placed the low cost of maintenance and cutting), and the produce is easy to steal. Should the experiment now on hand prove that it is possible to grow bamboos, the powers that be could very simply encourage others to try by reducing land revenue to a nominal sum for the first five or six lean years and correspondingly increasing it in the fat years which should follow.

I think that, always provided it can be shown to be feasible, bamboo plantations on the highest, and therefore worst, paddy and in the delta, will be a very paying proposition: Wabo and Kyathaungwa, allowing 50 per cent. for fall in price, over-estimation of the yield, etc., should yield Rs. 100 per acre clear profit after the sixth year. In the fifth and sixth years, a plantation should yield about one-third of this, say, Rs. 30 per annum: the cost of planting should not be more than Rs. 50 per acre. Maintenance charges (watching, etc.,) should be nil, as the owner will probably have paddy land yearly which needs watching; allowing Rs. 10 per annum for this (which I consider a maximum estimate) and calling the rate of interest 5 per cent. we get at the end of the first ten years:—

		Rs.
Expenses:—(1) Initial, Rs. 50 or in 10 years	...	81·45
(2) Annual, Rs. 10 for 10 years	...	132·07
Total	...	213·5

		Rs.
Profits :—(1) 5th and 6th years, Rs. 30 each year		78·49
(2) 7th, 8th, 9th, and 10th years, Rs. 100 each year ...	...	462·56
Total	...	541·05

Clear profit = 541·05 − 213·5 = Rs. 328-8-0.

First class paddy land, yielding an annual profit of Rs. 40 per acre, a high estimate, would yield a clear profit of Rs. 528-4-0 in the same time; but the difference would diminish year by year, until, if 15 years be taken instead of 10, the paddy and the bamboos show about equal profits; but there are next to no annual expenses in connection with bamboos while paddy has to be sown and reaped yearly. Therefore the bamboo yield would be clear profit, and is in addition about double that from paddy.

But the bamboos are assumed to be planted on the worst paddy land, not the best, and this, under paddy, yields an annual profit of only Rs. 10 to Rs. 20. If the former figure is taken, the profit from paddy is only Rs. 132; if the latter Rs. 264, in ten years; in both cases, less than that from bamboos.

It must be remembered that these figures are only estimates made on present prices; land revenue is not included, as it will make little difference to the result, or in any case may be included in the Rs. 10 per acre allowed for annually recurring expenses. The object of the experiment in the Kamase Reserve is to be able to supply information about both figures and methods.

With regard to fuel there is at present still less to go on. I think that the length of time taken to raise a crop, and the enormous supplies obtainable in the hill reserves will probably prevent it becoming a paying project for a private individual, although Government should be able to make small plantations on the worst paddy land pay more than the revenue derived from paddy. The discontent occasioned by any reservation of this sort, and the trouble and expense of maintaining such plantations must also be considered. When figures have been obtained from the Kamase Reserve, it will be easy to work out the result, and act accordingly.

SOME PROBLEMS IN CONNECTION WITH GRAZING IN THE CENTRAL PROVINCES.

BY C. A. MALCOLM, I.F.S.

The preparation of Working Plans for the Central Provinces forests has been making steady progress during the last ten years, and it must have struck anybody reading the reports how every successive plan devotes more space to a grazing settlement. It may, therefore, be worth while to examine the problems which had to be faced and the direction in which a solution has been sought.

2. The forests here referred to are only the poorer mixed dry forests, in which teak of small dimensions is often the principal species, and which are worked as coppice or coppice with standards. They are found in blocks of 5 to 50 square miles on the unculturable land between populous villages, from which there is often a moderate demand for timber, fuel and fodder, and a demand for grazing much in excess of what the block can stand.

3. The aim of forest management, since these areas were taken over 40 or 50 years ago in a half-ruined condition, was to restore them by careful conservancy. They were closed to felling, grazing and protected against fire, the idea being that a complete rest would effect a cure.

4. The extension of cultivation which, in spite of temporary checks through famine, progressed steadily at the expense of unreserved waste land, caused new demands on the reserved forests, and for the last twenty years or so exploitation of the timber and fuel of these areas has developed at a considerable pace, and the cutting of malformed and unsound trees has probably benefited the forests more than the long rest they suffered before.

5. It appears, however, that up to fairly recent times, grazing was looked upon as an unmitigated evil, and cattle were excluded where possible. If usage and local needs did not permit of total exclusion, an area was set aside for grazing, and fellings executed in the remaining closed area. This is a common feature in Working Plans prepared 15 or 20 years ago.

6. The results of this closure were contrary to expectation. It was a common case to observe that the grazed areas became

well stocked with teak, whilst in the closed areas teak growth remained confined to what was standing there originally. The explanation is, probably, that in the closed areas, the young teak seedlings get choked in the rains by high grass, or destroyed by fierce fires, such as occur during hot weather when fire conservancy is unsuccessful. In grazed areas the grass is kept low, and, if a fire runs through it, the seedlings generally escape with a scorching.

7. In any case, whether harmful or not, the demand for grazing in the smaller blocks had become so insistent that concessions were given and the Forest Officer has been faced with a threefold problem, *viz.*, what kind and number of cattle should be admitted, which cattle should be selected for admission, and how much they should pay for their grazing.

8. Although sheep and goats are undesirable it has been found impossible to exclude them entirely. They are allowed to graze in inferior areas excluded from working for timber and in some cases only in a special class of forest (C class forests in Berar).

9. Buffaloes are not welcomed, as, by their greater weight, they do more damage than cows, but exclusion is not always feasible.

10. There remain cows, bullocks and bulls, and it has to be decided in what numbers they can be admitted without detriment to the tree growth. Experiments on a small scale, backed by numerous observations, have generally led to the conclusion that, on the lighter soils, moderate grazing does not harm the tree growth, that three acres per animal are generally sufficient, and that even a smaller area can be allotted with safety in many cases, depending on the condition of the grass and local customs, provided that an adequate period of closure (put variably at from 5 to 10 years) is enforced after felling, to allow the coppice shoots to grow strong enough to escape damage. A resolution to this effect has been recently passed at the Conservators' Conference.

11. Having fixed on the maximum number of cattle that may be admitted to a block, there remains the problem of selecting

the cattle, and to decide which must be admitted and which can be excluded. The older Working Plans contented themselves with fixing the number to be admitted when they are not altogether silent on the point, and in provisional schemes and orders of more recent date an incidence of one animal for a definite number of acres was sometimes prescribed. But, in the Working Plans which have been published during the last eight or ten years, the prescriptions are much more detailed, and the villages which will be admitted to a block and the number of cattle from each village, are usually fixed.

It is doubtful whether these prescriptions go far enough in all cases. The declared policy of Government is that preference should be given to cattle necessary for agriculture, but the provisions of the Working Plans do not preclude the possibility of admission of other cattle to the detriment of agricultural cattle, and the greater the excess of cattle in a village over the number admitted, the greater the likelihood that non-agricultural cattle, owned by more influential villagers, will gain admission, to the exclusion of the poorer tenant's animals.

12. The remedy for this is simple. Agricultural cattle are already defined in the rules and may be grazed at lower grazing fees. The case would be met if, *e.g.*, for a village A with 100 working ploughs (from 1,000 to 1,600 acres), from which 450 cattle can be admitted (out of a total 600), a prescription were inserted in the plan running as follows:—

Cattle of village A entitled to graze at reduced rates will be admitted up to a maximum of 4 head per plough, provided they purchase licenses before the 1st of July each year. After that date other cattle may also be admitted until a total of 450 head is reached.

Such a provision would give every cultivator the first refusal up to the 1st July, after which there would be open competition.

13. The reader of Working Plan reports will also have noticed that to it is appended a note of some bulk by a Revenue Officer. This is a new departure introduced during the last ten years or so. When the Working Plans Officer has completed his

proposals and formed his felling series and coupes, a Revenue Officer (who may be an experienced Assistant Commissioner or a Deputy Commissioner if he can be spared), is deputed to satisfy *himself by local enquiry that the needs of the villages in the* vicinity have been considered in the plan. Although the scope of his enquiries extends also to the supply of timber, fuel and fodder, he is principally concerned with the grazing arrangements, and he must satisfy himself that adequate grazing facilities are given, and that villages are not periodically excluded through entire closure of areas to which they have access.

14. It would perhaps be better if this enquiry was held at an earlier stage. The Working Plans Officer, on completion of his stock-map, or description of block, will know how he would like to work his forests. If, at that stage, by a joint enquiry with the Revenue Officer, he could ascertain how far other objects of management must give way to the demand for grazing, he could frame his plan with that knowledge and would be saved the disappointment of having to recast his scheme on account of circumstances which his enquiry did not cover.

15. The financial aspect of the question is of interest. It is intended to obtain fees, commensurate with the value of the grazing offered, from professional cattle-breeders, and for the *commercial* cattle of a cultivator, *i.e.*, for live-stock kept by him in excess of his *individual* agricultural requirements, whether for the purpose of breeding, for sale or for the production of milk and ghee, whilst admitting his *bonâ fide* agricultural cattle at privileged rates. *This has been sought to be attained by fixing the number of* agricultural cattle, which a cultivator might reasonably be expected to keep, at 8 per plough in the Central Provinces and at 3 for 8 acres of cultivation in Berar, and by fixing grazing fees, which vary from district to district. The commercial fees range from 8 annas to Re. 1-1-0 per cow, and the fees for agricultural cattle from 1½ to 10 annas per annum. The value of the concession to cultivators is Re. 1-4-0 in Berar, but may, in the Central Provinces, be as much as Rs. 6-2-0 per plough of nominally 16 acres but often for very much smaller areas. The total grazing revenue at full

rates would have been Rs. 23·1 lacs in 1914-15, but the rebate allowed for agricultural cattle amounted to Rs. 9·7 lacs, reducing the total collections to Rs. 13·4 lacs.

16. Although the principle of assessment is admirable, the classification and scales of fees may need further consideration. *It would be preferable to fix the number of agricultural cattle separately for each district.* The cattle statistics and settlement reports show that 8 cattle per plough, or 3 cattle for 8 acres, are too liberal an allowance, as the average cultivator owns fewer head, and though this allotment may possibly suit some of the more backward tracts, in the highly developed districts of Berar for instance, 3 animals for 20 acres of cultivation would cover all the *bonâ fide* agricultural stock. The excess allotment of agricultural cattle, combined with the very substantial difference in rates, is apt to lead to abuses, and much legitimate revenue is lost because commercial cattle graze, under cover of privileged licenses, either because they are grazed in the name of another cultivator, who cannot utilize the concession in full, or, because a cultivator, who is also a cattle-breeder, is returned as the owner of more ploughs than he requires or uses and so obtains grazing at privileged rates for his commercial cattle. Much can, of course, be done and is done, by supervision and check, but it is not right to put so great a temptation in the way of the cattle-owner and the subordinates on low pay who prepare the cattle and plough returns.

17. There are two remedies which could be tried singly or in combination. One is, as suggested above, to reduce the number of privileged cattle to that commonly kept in the district; the other is to reduce the difference between the commercial and privileged rates. The financial result, *e.g.*, of a commercial rate of 8 annas and a privileged rate of 3 annas, would probably be the same as the present 10 annas and 1½ annas and an intermediate 7 annas rate.

18. There are of course other methods of securing concessions to agriculturists. In tracts where plough bullocks wear nose-bands, they could be admitted free, and a uniform rate charged for cows. The practice found in some private estates, and also in

parts of Hyderabad, of allowing free grazing of cows and of charging fees for bullocks, is unsuited and has been adopted with a different object. But any system, to be a success, must be easily understood and difficult to evade.

19. It is hoped that this article may be of somewhat more than local interest. Similar conditions must be found in many forests in the Deccan, where the Forest Officer has faced or will have to face such questions. The writer has worked since 1906 in tracts where cattle in need of grazing in Government forests were largely in excess of the number that could be provided for, and the views expressed are based on the experience gained during this period.

PROGRESS OF SILVICULTURAL WORKS IN NORTH KANARA DIVISION.

BY J. DODGSON, I.F.S.

1. This note describes the cultural work now carried on in a systematic way in the forests of the Haliyal Range.

2. These forests are composed mainly of three species, Teak (*Tectona grandis*), Dindal (*Anogeissus latifolia*) and Matti (*Terminalia tomentosa*). Other species such as Blackwood (*Dalbergia latifolia*), Kindal (*Terminalia paniculata*), Honni (*Pterocarpus Marsupium*) and Nana (*Lagerstrœmia microcarpa*) are sparsely scattered. The largest teak trees reach about 16″ diameter and 50′ in height. The area is being worked according to the prescriptions of the Haliyal Teak Pole Working Plan, which was introduced about the year 1903-04. The system of working is coppice with standards. Previous to the writing of the plan no silvicultural works were carried out in this area.

3. Under "Sowing and Plantings" the plan prescribes that "a man on daily wages should live in each coupe for one year after it is felled, to rear and plant out, during the monsoon seedlings of the species required locally."

4. This prescription was carried out more or less until the year 1913, when Mr. Copleston noticed that, as soon as the first rain

falls in the month of June, a fine crop of seedlings appeared in the newly exploited coupes. As these seedlings were not tended, they were soon smothered by the grass and disappeared. Mr. Copleston thereupon took steps to have the seedlings protected, and the cultural operations then started are still continued.

The operations are briefly as follows :—

5. In the month of June of each year, the Guards and Coupe Mali (a cooly, termed a Coupe Mali, is allowed for each newly exploited coupe) go through each newly exploited coupe and mark each teak seedling by fixing a teak-wood stake 3 feet high firmly in the ground on the west side of the seedling and one foot distant from it. This stake not only marks the plant but is used later on for supporting a grass shelter which shades the seedling.

6. As soon as the seedlings are marked with stakes, a space of $1\frac{1}{2}$ feet round each plant is weeded and the earth slightly loosened. Weeding is done at least once a month throughout the rains.

7. During October and November, the teak seedlings are earthed up with loose earth for a space of 2 feet round each. During December grass shades are placed on the stakes to shade the seedlings. These shades are removed in April and the grass is placed round the base of the seedling.

8. In addition to this work, small local nurseries are made, and the seedlings from these are transplanted, in the month of July, into blanks where no natural seedlings are to be found. Only 15-month-old plants are transplanted.

9. In the second year the plants, formerly marked, are again inspected, weeded and blanks caused by the death of the previous year's plants are filled up.

10. In the third year the area is once again gone over and plants in danger of being smothered by grass are cleared. After the third year the plants are left to themselves, as by this time they have got a good start and are able to compete with the grass.

11. The tended plants found alive on one acre, in the coupes exploited in the years 1913-14, 1914-15 and 1915-16 of Blocks VI, VII and VIII, were counted. Each coupe was carefully searched, and the acre selected represents the average growth for

the whole coupe. The average number of plants found per acre was in the coupes of—

1913-14	plants	277.
1914-15	"	245.
1915-16	"	373.

12. As no record was kept of the failures it is not possible to give the percentage of failures for the coupes of 1913-14 and 1914-15. For the year 1915-16, however, it is found that there were 18 per cent. of failures.

13. The height of the plants varies from an inch to 4 feet. The average expenditure per acre (excluding the pay of the permanent establishment) is Rs. 3-6-0.

The experience of three years has proved that—

(*a*) the plants must be kept free from weeds ;

(*b*) the soil round the plants must be kept loose ;

(*c*) the grass placed round the plants must be entirely free from, and not touching, the plants. The layer of grass must not be too thick, otherwise the plants grow 'leggy' and weak ;

(*d*) grass shades are only necessary on dry, exposed aspects. In localities favourable to the growth of the plants, the shades (unless the malis are very attentive) hinder the growth of the plants, and are a source of danger from fire.

14. Transplants show quicker height-growth than natural seedlings.

POSSIBLE USE OF PHENYLE IN NURSERIES.

BY H. H. HAINES, I.F.S.

I should, perhaps, prelude my remarks by stating that I refer to nurseries for plants, not children. Further, that I do not know the composition of *Phenyle* but presume that it belongs to the series of disinfectants (Sanitas, etc.), of which the active principles are Phenol and Cresol or Carbolic Acid, and that, therefore, its good effects on plant life are not likely to be due to any manurial properties.

In August last year, very weak solutions of phenyle were applied to pots of Caladium, Tobacco, Ferns, Verbenas, Phlox and Geranium, and as it appeared to have no ill effects, I began experimenting with it up to October, when touring put an end to the observations.

The subjects of experiment chosen were some Verbena plants attacked by a rust, Tobacco with a fungoid disease (nature unknown), some Verbena attacked by minute yellow-green larvæ, and Geranium cuttings. In those cases, watered with the solution, the diseased plants all showed marked recovery and some were completely well by October, whereas, of the check plants not watered, none had recovered and several died.

Beginning with very weak solutions, the strength was gradually increased to ·5 oz. phenyle to 2·5 gallons of water. This strength the plants seemed to stand with impunity, and some showed considerable luxuriance, even compared with those pots which had not been diseased. A further increase of strength to ·75 oz. phenyle to 2·5 gallons of water appeared, however, too strong and to injuriously affect the leaves.

In the case of Geranium cuttings, the plants treated with the phenyle solution showed no signs of rotting, whereas some of those not so treated failed to strike.

I do not pretend that the above experiments have so far any value; they were far too slipshod, and the medicated waterings were not continuous, but it is possible that, as the material is cheap, diseases such as rust, mildew, erysibe and others affecting plants in forest nurseries might be successfully combated by the same methods.

GROWTH OF *SOYMIDA FEBRIFUGA* IN TRICHINOPOLY.

BY M. RAMA RAO, EXTRA-DEPUTY CONSERVATOR OF FORESTS.

In the Karumantapam mango tope of the Trichinopoly Municipality there are six *Soymida febrifuga* trees. They were planted in 1869 when the tope was formed by Mr. Banbury, then Collector of the district. The soil consists of deep red loam, darkened by humus on the surface. A shallow tank, immediately west of the tope, helps to maintain the subsoil moisture of the tope during a considerable part of the year.

2. The trees are much larger and more vigorous and healthy than those found in forests in the Kurnool, Trichinopoly and Salem districts, where the species is occasionally met with. Their measurements, recorded in June last, are given below :—

Number of tree.	Girth at breast-height.		Height of bole to first branch.		REMARKS.
	ft.	in.	ft.	in.	
1	5	11	13	0	Standing a little away from the tank bund, fairly sheltered all round.
2	6	0	9	9	
3	6	9	10	6	Standing on the outer slope of the tank bund, unsheltered by other trees on the eastern side.
4	5	2	10	0	
5	7	5	9	6	
6	5	5	12	0	

It will be seen that the girth development of the trees is very good, but the stems are comparatively short while the crowns are fairly dense and heavily branched.

3. With a view to ascertain the quality of the wood and the rate of growth, a dying branch, which was at a height of about 8 feet from the base of one of the trees, was felled on the 26th April last, and it measured, on the 17th June last, 2 feet 4 inches in girth

with an average thickness of bark $\frac{3}{8}$ inch and sap-wood 1 inch. There were ten concentric rings in the sap-wood and 26 in the heart-wood. This works out to about nine rings per inch of radius in the branch-wood. The rate of growth indicated by this branch cannot be taken to represent that of the trunks of the trees; for the average girth at breast-height of the six trees works out to 6 feet $1\frac{1}{3}$ inches over the bark, or a diameter of $23\frac{1}{3}$ inches. Deducting $\frac{3}{4}$ inch for the thickness of the bark, the diameter of the wood comes to 22 inches, representing a radial growth of 11 inches in 47 years, or 1 inch of wood in 4·3 years. It would be *interesting and instructive to find out by felling one of the trees,* say tree No. 2, which has a girth of 6 feet, and carefully counting its rings, whether the actual growth of the large trees approximates to this rate of annual increment.

4. The sap-wood was whitish-brown, and the heart-wood reddish-brown when first felled, but in June the sap-wood had turned light reddish-brown, and the heart-wood dark-red and was very heavy. The wood-fibres were fairly straight and smooth, and not twisted, as observed by Mr. Gamble in other samples elsewhere.

5. All the *Soymida* trees in the tope bore an abundant crop of fruit successively in the summers of 1915 and 1916. Whether this species seeds annually in indigenous forests does not appear to have been recorded yet.

6. The rapidity of its growth in Trichinopoly and the high value of its timber seem to call for greater attention to the cultivation of *Soymida* in Central and Southern India than it has hitherto received.

SUNDRI (*HERITIERA MINOR*).

BY BIJAY KUMAR BHATTACHARJI, FOREST RANGER.

Sundri is, to the Indian Forester, perhaps the most important species of the Sterculiacæ, being a valuable timber tree. It forms, with a few other species, the most important of which are *Sonneratia apetala* and *S. acida*, *Avicennia officinalis*, *Carapa moluccensis* and *C. obovata*, *Excœcaria Agallocha*, *Ceriops Roxburghiana*, *Amoora cucullata*, and *Rhizophora mucronata* and *R. conjugata*, a separate type of Indian forest, called Tidal forest.

The heart-wood of Sundri is dark-red, very hard and extremely durable. It is very heavy, weighing 67 lbs. or more per c. ft., and therefore will not float. It does not season well, and is liable to shrink if sawn into thin planks. It is extremely strong ($P = 900$) and is very difficult to split, especially when dry. The green wood, however, splits easily. It is rather difficult to work but takes a moderately fine polish. Owing to its hardness, white-ants do not attack it. It is also more or less immune from marine-borers. Apart from the defects in seasoning, it is one of the best timbers for elasticity, hardness, strength and durability.

It is the timber most extensively used in Southern Bengal, especially in the districts of Backergunge, Khulna, and Twenty-four Purgannahs and it acquires popularity wherever it has once been used. It is one of the all-round useful timber trees of India, and may be used for almost any purpose. It is used for all kinds of bridge and building constructions, for boat-building and agricultural implements. If suitable sized timbers be found, they would yield very good railway sleepers. It makes, moreover, an excellent fuel. In fact, when Sundri has recovered from the injuries resulting from unregulated fellings in the past, and with improved methods of extraction and communication, the Sundarbans forests will constitute one of the richest sources of supply of timbers for a variety of uses.

Soil and Locality.—Sundri is found growing from the very beach of the sea (the Bay of Bengal), but does not extend far inland. The presence of some salt in the water seems to be indispensable for the growth of Sundri, though an excess of salt is

injurious. It naturally falls into two different types of forest, the salt-water type and the fresh-water type, the latter being by far the better of the two. It attains larger dimensions, with little or no undergrowth, in the latter type.

This fresh-water type affects the northern and interior parts of the forests and does not coppice well.

The salt-water type, on the other hand, is extremely slow in growth, stunted and more or less open. It flourishes in the area near the sea-face, and is also found on the high ground forming the banks of all big and middle-sized Khals, but it seldom extends beyond a couple of hundred yards from the edge of Khals. Coppice reproduction is more vigorous in this type of Sundri.

Sundri thrives best on a low-lying, moist, clayey loam with a slight admixture of salt. In very wet soils, however, as well as in salt high banks, its growth is rather stunted.

Shape and Development—Sundri grows in close crops so that it is seldom found with branches low down. The crowns of individual trees are rather light, but their combination forms a close canopy through which the rays of the sun scarcely penetrate, and even when a fair breeze is blowing outside, there is not a breath inside, and one gets drenched in perspiration as soon as one enters the forest.

The tree has a shallow root-system and is often supported by buttresses. It sends forth copious knee-shoots which serve as respiratory organs as well as mechanical supports. These vertical root-shoots, moreover, check water-currents, and lead to the deposition of silt. The suckers of Sundri are compressed and rigid, and arise from the points where the true roots branch. The abundance of these knee-shoots in wet localities is especially noticeable. It is on account of these 'Shulas,' as these blind shoots are called, that it is so very difficult to walk in Sundri forests.

Unlike Golpatta, Sundri can endure a considerable amount of overhead cover. Its rate of growth is very slow, being as little as a fifth of an inch in girth a year in bad localities. At present, trees of 4 feet in girth are scarce, and trees over 3 feet are,

as a rule, unsound. But, when the forest has recovered from its present bad condition, it is hoped that a girth of 6 feet will be no uncommon thing.

Reproductive Power.—Sundri bears fruit annually. The flowers appear in March and April and the fruit ripens and the seeds fall from July to September.

The fruit is a single-headed, ribbed drupe, the ribs forming a sort of beak at the apex of the fruit. It is covered by a hard epicarp which protects the seed ; the mesocarp is fleshy and oily It does not keep good for a long time and cannot stand long immersion in water, though a slight soaking favours germination. It is much attacked by insects, and large quantities are carried away by the tides.

On account of its weight, the seed is not carried far, and usually germinates under the parent tree. Germination is rather slow. After the seeding season is over, the whole ground is matted with seedlings.

Sundri, as a rule, does not coppice well.

Character and Composition of the Forest.—Sundri is a markedly gregarious species, and always tends to form pure crops. Like Deodar, there is a marked tendency for the young trees to keep to the same level. There is little or no undergrowth in Sundri forest. The floor is covered with a dense growth of 'Shulas.'

The scanty undergrowth in the Sundri forest is mainly composed of Amur (*Amoora cucullata*), Gengwa (*Excœcaria Agallocha*), Goran (*Ceriops Roxburghiana*) and Udoban (*Acrostichum aureum*).

Method of Treatment.—Owing to neglect in the past, the present forest is now in a very poor condition. The forest was looked upon as capital, the more of which was extracted, the greater and better the profit. The purchasers used to select the trees, so that no trained staff was required.

On account of these unregulated fellings all the bigger and better trees have been extracted and the forest is now composed of young saplings of recent growth, together with over-mature, unsound and decaying stems—the refuse of former workings. By

the notices issued in 1875 and 1885 no Sundri trees under 3¾ feet in girth could be felled; but now a sound stem of over 3 feet in girth is somewhat of a rarity. Formerly, trees of 6 feet in girth were not uncommon. The protection of the last 13 years (from 1903-04 to 1915-16) has, however, resulted in the establishment of a promising crop of young saplings.

The first Working Plan, made in 1893-94, was based wholly on financial considerations, and prescribed no method of marking—the trees being sold on permits. The first regular Working Plan was made in 1903-04.

On account of the present poor condition of the Sundri, no regular method of treatment is possible. It is at present treated under Improvement Fellings with Thinnings, which is the only suitable treatment at present. But when the growth has recovered from its present state, some regular method of working will have to be prescribed.

As above stated, the coppice system is unsuitable, but as *it forms pure crops, the Group or Uniform Method of High* Forest would suit it well. Objection might be raised to the adoption of the Uniform Method on account of danger from high winds and cyclones. The Group Method, however, may be safely applied to it.

Of subsidiary operations thinnings only are needed. As every stem in the crop tries to raise its head to the level of the general canopy of the forest, thinning does much good by helping the trees of the future. As the forest is pure and undergrowth scanty, no other subsidiary operation is required.

Dangers and Damage.—High winds and cyclonic storms are the only dangers to be guarded against. A shelter belt of one or two chains width, along the banks of all rivers and big Khals, would do a good deal of good.

Insects, both defoliators and wood-borers, infest the forest. The only way to fight these is to keep the forest clean. With this object, dead and dying trees should be marked both in Thinning and Improvement Felling markings; and the purchasers should be induced to remove them.

Methods of Extraction.—There are no roads in the Sundarbans, and even, if there were any, extraction along them would be very difficult on account of the depredations of man-eating tigers. The net-work of rivers and khals which traverse the country constitute a magnificent system for water extraction. The timber is hauled to the banks of khals or rivers by men, and there loaded on boats and thence transported chiefly to Backergunge, which is the biggest market for such produce.

Economic Uses.—Besides those mentioned above, the timber is used for furniture-making, door and window frames, planking and shafts, piles, etc., etc. The buttresses are used for making blades of oars and helms. The gum, exuded from wounds made in the bark, is clear and transparent, and is used in Hindu medicine as well as for adhesive purposes. An oil may also be extracted from the mesocarp of the fruit.

THE SYSTEM OF MARKING IN THE SOUTH CHANDA DIVISION.

BY G. M. WILLFORD, E. A. C. FORESTS.

Marking is, as a rule, looked upon as being monotonous and tedious, but the way it is done in the South Chanda Division of the C. P. does away with most of the monotony, as small Gond boys, averaging 12 years in age, are employed, instead of sedate men, and the former take a great interest in their work, and sing heartily while doing it.

The coupe having been laid out, the marking is done in strips (3 to 4 chains in width) running parallel with one of the boundaries. The trees to be felled are hammered, and numbered serially.

The work partly consists of a marking officer, three forest guards, two adze-boys, and about ten small boys. The strip to be marked being decided upon, two boys are detailed off as line-boys, who take up their positions on either side of it, *i.e.*, one walks along the coupe boundary line, and the other 3 to 4 chains distant, inside the coupe.

The space between these two line-boys is taken up by the marking officer, with a forest guard on each side of him. Immediately behind these, seven small boys, two adze-boys, the hammerman and his attendant, take up their positions. The hammerman has a note-book, in which are entered all the numbers of the trees likely to be marked in the day's work, and his attendant (one of the small boys) carries a small box, so designed as to hold the numbering dies in one half, and a pad soaked in coal-tar in the other.

After the forest guards and boys have taken up their positions as described above, the word to proceed is given, and the party moves forward, the line-boys keeping a few paces ahead, and singing in response to each other, "Line ya hai" (the tune being rather like that sung by the man throwing the lead on a river steamer). Their object is to keep in touch with each other, so as to remain as far as possible a uniform distance apart, and also to guide the party within the strip. The boy, who walks away from the coupe boundary, lightly blazes trees with his axe, which shows the line he has walked along, and which is followed by the other boy on the return journey. As the party advances, the marking officer walks in a zig-zag fashion from one side of the strip to the other, pointing out the trees selected for removal to the forest guards on each side of him, who tape the girth. The result the marking officer enters in a register along with the serial number, the proximate length of bole, the species, and any other remarks that appear necessary. He then writes the number allotted to the tree on a slip of paper, and hands it to one of the seven small boys behind him, who, on receiving the "chitti," stands by the tree under reference and attracts the attention of the adze-boys by singing "Kharab sagwan chheelo" (the tune being very much like that of the line-boys). Although the little imp may be standing by a sound tree, he calls it 'kharab' (bad) because the marking officer has ordered it to be marked. One of the adze-boys then comes along and cuts a blaze (about 8 inches square) at the base of the tree for the hammer mark. This done, the small boy changes his song to "Kharab sagwan nikalo," which is another way of telling

the hammer-man that he is wanted. These three words are sung to a fast tune probably because the boy gets impatient and is anxious to take over another tree. The word 'sagwan' (teak) is changed according to the species.

The hammer-man obeying his summons arrives at the trees, takes the slip of paper bearing the number from the boy, and cuts out the corresponding number in his note-book, which serves as a check on the numbering and prevents the possibilty of a number being omitted, or two trees being given the same number. He then takes the small box from his attendant, and after pressing the hammer and numbering dies on the pad of coal-tar, he hammers and numbers the tree; the coal-tar thus gets embedded into the wood, making the impression of the hammer and numbers distinct and lasting. While the marking operations are being carried out in respect of any one tree, the marking officer is selecting other trees, and everybody is busily engaged in work to the merry accompaniment of the medley of "Line ya hai," "Kharab sagwan chheelo," "Kharab sagwan nikalo," and frequently "Accha sagwan pila" or "Accha sagwan pilu." This is sung by the boys by way of a variation and is probably derived from old times, when the trees were measured by means of callipers and "pila" or "pilu," meaning yellow, was the colour on the calliper most frequently called out.

The marking officer has a trace of the coupe made from the 4-inch sheet, on which he plots the strips marked during the day and the numbers of the trees in each strip. By doing this, he can fairly well judge how much longer it will take him to finish the marking, and later, when the coupe is being felled, it helps in locating any special tree.

The boys employed are the sons of forest guards and forest villagers of Allapilli Forest village and are literate, having attended the departmental school there in their earlier childhood. They are also engaged for the improvement fellings, so that, by the time they come of age, they have got a fairly good training, and are very suitable for employment as forest guards.

BUTEA FRONDOSA EVOLVING SIMPLE LEAF.

BY S. S. SHIVAPURI, FOREST RANGER.

"Dhak ke tin pat" is a trite saying and hackneyed repetitions of the above expression occur in many of our vernaculars. The underlying idea on which this is based is the ever constant trifoliate leaf of the Dhak tree, *Butea frondosa.* Why this particular forest tree was chosen and thus crystallized into a by-word will, perhaps, remain an open question, except, owing to the fact that it is the most common indigenous tree of the Upper Gangetic Plain where the halt of the incoming Aryans was longest, and because its wood was one of those employed in the ancient sacrificial fires, which brought it to much prominence.

Now, to many of us, it would come as a surprise to be told that the Dhak is now evolving a different, *i.e.*, a simple foliage.

Along the outskirts of the Bichore Forest Block, Singoli, Gwalior State, there is growing, in a flourishing state of health, a Dhak tree that combines (1) single foliate, simple; (2) 2-foliate, compound; and (3) the common form of 3-foliate, pinnate, compound, leaves on its different twigs and branches. The shape and size of the simple leaf is like the usual leaflet. The neighbouring Dhak trees, all round, and in plenty, possess the ordinary trifoliate compound leaves. People have not been slow in recognizing this phenomenon to be a manifestation of Nature and they have consecrated the tree to their local god. The tree, I am told, puts forth the yearly inflorescence, though I could not find any young single-foliate seedling or root-sucker there.

Moreover I have come to know that in other parts of Central India and Central Provinces forests, namely (1) at Sonkach near Ujjain and (2) at Itarsi in C. P., there are similar abnormal specimens of *B. frondosa.*

Would it be too much then to expect that in course of time this very specimen, or another more powerful, will eliminate the old-typed 3-foliate leaf altogether, decide on a single-foliate, simple leaf. I do not say it will decide on a 2-foliate leaf, because, I suppose, from the majority being simple leaves on the tree under

notice, that the stage of 2-foliate leaf is merely one of transition giving place rapidly to the simple form.

Comments and further light on the subject would be welcome.

EXTRACTS.

DEVELOPMENT OF INDIAN FORESTS.

The State forests in British India aggregate nearly 250,000 square miles, or more than one-fifth of the total area under English administration. This huge estate is controlled by the Government in the interests of the people of the country, but, as so often happens, the beneficiaries know every little of the work of their trustee, and when Indian politicians speak of the forests at all, which they seldom do, it is usually to rail at the detailed administration and expatiate on the hardships suffered, or alleged to be suffered, by a relatively small number of individuals whose interests clash with those of the community as a whole. This combination of ignorance and misrepresentation is peculiarly unfortunate at the present time, since, as we propose to show, all is not well with the administration of the forests, and the needed improvement could be accelerated materially by the pressure of informed public opinion, a pressure which now operates and, on the whole, beneficially—on various other departments of the public service in India. The blame for the present position must rest on many shoulders, but no small part of it is due to the fact that while forest administration, like any other big business, is necessarily technical, its operations are rendered quite unnecessarily obscure by the technicalities in which they are described; we shall attempt to avoid this evil, and explain as clearly as possible what the forest administration is now doing, and what measures are needed to secure to the people of India the full benefit of their enormous but still undeveloped estates.

The first duty of the administration is to keep the forests in existence. Some areas now classed as forest may ultimately be required for other purposes, agricultural or mining or what not, but the bulk of the land is fit for nothing else, and in the Indian climate this land must be kept covered with vegetation in the interests of the rest of the country: bare hillsides mean floods

and drought in the plains as well as the sterilization of the land immediately below them. This primary duty, which is known technically as conservation, is now on the whole effectively performed; it is costly work, and probably it could be improved if more money were spent on it, but the conservators, as the superior officers are termed, have in this matter deserved from the country very much more gratitude than is ever likely to be manifested. The second duty is to pay expenses by selling the forest produce as it matures, and here, again, the administration can claim substantial success; the revenue which India draws from the forests may be put at about a million sterling annually after all expenses have been paid. The third duty is to raise this net revenue to the maximum, and here the administration has, in our opinion, fallen seriously behind; as will appear later on, we make this charge not against the technical officers, but against the superior administration of India as a whole.

A million sterling sounds a large sum, but let us remember that it is drawn from a large area; it works out at less than two annas an acre of the area now in charge of the administration, and that we venture to think is ridiculously low. Some Indian forests already yield ten rupees an acre, and while it is scarcely likely that the average can be brought up to this sum, it does not seem by any means impossible that in process of time the existing revenue should be multiplied by ten, to the great advantage of the country as a whole, which requires a largely increased income to meet its developing expenditure. Large areas now covered with practically worthless jungle could with proper management yield highly remunerative crops of timber; much useful timber cannot be profitably disposed of because there are no means of getting it to market; while there is an abundance of minor produce, dyes and tans, gums and resins, grasses for paper-making, and so on, which need only effective pioneering to secure an advantageous market, and thereby assist very materially in the industrial development of the country. India as a whole is poor, yet here we have immense natural resources either left unutilized or not utilized to the best advantage. As we have said above, we do not blame the forest

officers for this waste. For long years the department was starved; with inadequate supervision, badly trained subordinates, and practically no facilities for research, it is extraordinary how much was achieved. In these matters the last decade or so has seen a material improvement; questions of staff and remuneration have received some attention, technical training has been placed on a sounder basis, and provision has been made for the research which is an essential preliminary in any forward policy. Thus the Government of India has of late done much to fulfil its duty to the country; but one more step is still needed without which the measures already taken will assuredly fail to fructify.

The need now is capital. Capital is wanted for establishing more remunerative crops; capital is wanted for improving communications in the widest sense; capital is wanted for pioneering markets; and from all quarters we hear the same story that capital is not to be had, or that at best it comes in petty and irregular driblets where the need is for a steady fertilizing stream. To explain why capital does not flow to the forests we must turn for a moment into a by-path in the jungle of Indian finance. In technical language, forests are provincial, that is, their income is taken and their expenditure controlled by the Provincial Governments, and this fact is of very great practical importance. To begin with, a province has no control over capital funds: it cannot borrow, and while it can obtain from the Imperial Treasury capital grants for certain specific purposes, such as irrigation works, forest *development is not at present one of those purposes. It follows* that a province can finance development only out of its current income, and that is a very difficult matter indeed. A province is allowed to spend a certain income, drawn from the revenue which it collects, and very nearly the whole of its allotted income is required for current needs, such as salaries and maintenance of existing institutions. Each autumn the Financial Secretary estimates his free balance for the next year, and if times are good he may find himself with a few lakhs in hand. All the departments forthwith join in a scramble to get as large a share of those lakhs as possible: the forests want development, but at the same time the police want

higher pay, the Sanitary Commissioner wants drains, the engineers want roads and bridges, and, whatever the surplus may be, the Director of Public Instruction inevitably wants the whole. The forests thus take their chance with all the other departments, and they are unfairly handicapped in the struggle.

In the old days a strong Lieutenant-Governor might conceivably have seen fair-play, and set aside adequate provision for the needs of the future, but those days are gone: popular demands must be listened to, and there is no popular demand for forest development. Again, the allocation of the free balance is influenced to an increasing extent by the members of the Legislative Council; not one of the elected representatives raises a voice for the forests, while a reference to the Civil Lists will show that while other heads of departments are able to press their demands in person, not a single Council includes a Conservator of Forests whose claims must be presented at second-hand by the Secretary in charge of the department. It is utterly absurd to suppose that in such circumstances money for developing the forests can ever be forthcoming to the amount required; a province with extensive forests may easily want the whole of its free balance for forest development alone, for development costs money; but the Conservator can hope for at the best a very exiguous share, and even this share is likely to diminish with the increase of popular and *therefore short-sighted control.*

The remedy for this disastrous hindrance to the enrichment not merely of the Government, but of the country and the people, appears to us to be obvious. Put productive forest development on the same footing as productive irrigation works; let the Government of India raise the necessary funds as part of its annual loan, and let it charge the provinces interest on the sums which it provides for their needs. Even a poverty-stricken province can find the interest on a capital sum which is entirely beyond its resources, and popular opinion will welcome an arrangement which looks so like an Imperial grant. Once assured of the requisite capital, the Conservators can safely enter on a steady and comprehensive policy of development, ensuring a gradual rise in

net revenue, until at last the country will enjoy the full advantages of the great estates reserved for its benefit by the foresight of an earlier generation. It is unequalled opportunity for the statesmen and financiers who control the destinities of India.—[*The Indiaman.*]

The following article from the pen of H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., which appeared recently in the *Agricultural Journal of India*, will be of more than passing interest in these days of war against man and disease :—

THE CONTROL OF FLIES AND VERMIN IN MESOPOTAMIA.

There have been urgent reasons for dealing with flies and vermin among the forces in Mesopotamia this year, and I was fortunate in being sent up at the end of April to investigate and decide what could be done. Even on the way up, there was entomological work to do. The hospital ship on which I travelled from Bombay had been long in the tropics and was full of small red ants which were a sore trouble to the wounded and sometimes worse. As the ship was going up empty, there was full scope for work and after failing with one method, we succeeded with another. Baits were put down (usually syrup on rags) and the trail of ants to the nest traced back. The nests are all behind wood-casings and the cracks of exit were oiled with a mixture of paraffin and lubricating oil. This isolates the nest inside with the queens and the workers outside cannot bring food in. In three days there were no more trails or nests discoverable and the plague was under control.

Basrah was hot and stuffy but not markedly plagued with flies; but as one goes up river it gets worse at every camp till the climax is reached at the most advanced post where Corps Headquarters are situated. The flies are mostly the Housefly type, *Musca*, of several species probably, a few Blow flies of the *Calliphora* tpye, and some *Stomoxys*. The last is a nuisance on the river as it bites so sharply but it is not a disease-carrier and is not really common on land.

To fully appreciate it the abundance of flies has to be seen and still more to be suffered. The tents and trenches are full of

them. By night they sleep in masses on tent roofs, etc., in the morning they awake to furious activity as soon as the sun has warmed them, till midday they feed and fly and buzz; then they seek deep cool shelter if it is hot, say over 110° F. in the tent, and go to sleep. In my tent they preferred to get under the bed on the side of the pit in which one lives. At evening they start again and are very active from 5 to 7. When one has been driven crazy it is good to go and see the patient resignation of the sick and wounded and therefrom to learn control and resolve more strenuously to destroy the scourge. And then one remembers that nearly every disease in Mesopotamia is one that is carried by water and flies only, and one realises that the fly is really a serious factor in this campaign.

Another entomological problem is of some importance in Mesopotamia, and this is the control of vermin and sand-flies, fortunately no difficult matter. The former convey relapsing fever and typhus, the latter carry sand-fly fever; both are the cause of irritation, the sand-fly especially; there have been cases of serious septic sores from sand-fly bites and the sand-fly has been one of the real plagues of life. Fortunately there is a cure for both. In 1904, the use of Crude Oil Emulsion was first introduced by the Entomological Section for vermin on animals; early in 1915, a refined form of this was shown to the War Office, and in May was adopted as the official vermin remedy for the army. It is now being made in large quantities in Bombay and sent up to Mesopotamia. In the Army it is known as "Vermijelli," but as this is a registered name, the property of a firm in London, it is called "Sand-fly and Vermin Ointment." It has the merit of keeping off sand-flies and mosquitoes, if rubbed very lightly on the hands and face. I had one tube with me in Mesopotamia. I did not realise the sand-fly was there and was badly bitten the first night; I was never bitten again, I used no net and all who shared my tube found the same. It is now being issued for this purpose. For vermin the emulsion is rubbed on the hairy parts of the body and on the seams of clothing; under-clothes are washed with it and dried without rinsing so that the clothes are lightly impregnated with it,

With regard to flies there are really three problems in Mesopotamia, the control of flies in camps, trenches, etc., in towns and with moving bodies of troups. The first is the important one because it is the biggest and, in some ways, the easiest to deal with. The breeding places in camps, trenches, etc., are of three kinds. The latrine trench is far the worst, accounting for probably 90 per cent. of the flies ; the accumulations of stable manure, and the accumulations of refuse and offal account for the rest. The latrine trenches are about 18 inches deep, a foot long, six inches across ; a series are dug side by side, according to the number of men. They are filled up daily. They offer the ideal breeding place for flies and they swarm with flies laying eggs when they are in use and are solid masses of maggots in a few days. Flies emerge from trenching ground in hordes, get their first meal at the nearest trench then in use and then distribute themselves over the camp.

Stable manure was comparatively harmless owing to rapid desiccation ; only when small amounts were swept up with dry litter and so preserved from drying did one find maggots and the manure is nearly all dried and burnt. Kitchen refuse and offal are usually burnt or buried but would easily breed flies. The greatest care is usually taken and it is only carelessness on the part of the sweepers or camp cleaners that allows this material to breed flies.

In most places in Mesopotamia there is absolutely no other source of fly breeding ; the land is flat, dry, absolutely barren as a rule ; there is no shade, a fierce sun bakes it, a dry wind blows furiously. Only where man is, can there be shelter, food or breeding places and there is no man but soldiers in the war area. There are stories of bodies of men trekking into the bare open country and finding hordes of flies, but they took these with them. When one comes out of the trenches, flies settle on all the areas shaded by one's *topee* or oneself and on all the shady parts of one's horse ; they travel on one thus for miles, unable to fly away in the fierce sun. In this way one carries swarms of flies and a body of men, when they camp, will naturally find their tents full of flies.

No place strikes one as so easy to clear of flies as a camp, as all is done in full view, there is nothing hidden and one can control everything. There are no houses, no back-gardens or filthy alleys, no refuse dumps or collections of rubbish. It is a matter of deciding what to do and having it done.

The second problem will be more difficult because it is not so easy to control a town. In Basrah and Amarah there are large areas of camps, with streets of houses not far off; the problem is not so simple because of the uncontrolled breeding places of the native houses, and it is more a question of extensive fly killing (as described below) than of prevention.

The third problem again is difficult because of the limited resources of a moving body of men. Such a body of men will not suffer from the flies they breed ; they suffer from the flies bred by other moving forces before them and there are camping grounds on lines of communication where you arrive to find that swarms of flies greet you and millions are then emerging ; that means that ten days before a body of men camped there, used latrine trenches, and probably did not trouble too much about the disposal of kitchen refuse and offal.

Having examined the problem and especially having seen what was needed for the trenches, the field hospitals and the head-quarters and other camps, it was a question of getting supplies and a staff of men to carry out the obvious measures. All the supplies that went with me from Bombay were snapped up at once and much more was needed. Everyone in charge of hospitals particularly needed help and supplies ; it is a real experience to go round the tents of a cholera or ordinary hospital, and to see what a curse the flies are to the men. Then one sees the operating tent and realizes that flies may come 100 yards from a near by latrine to vomit their last food on the exposed tissues of a patient ; one sees flies settling on a fresh wound, and the men fighting them off while it is dressed. No wonder every single person is keen to help the fly campaign and that every possible assistance is being given to those who are trying to reduce this pest.

A short simple set of instructions was prepared and issued; the measures recommended are discussed here in turn.

1. As far as possible, replace latrine trenches by tins and incinerate. This system is very widely used: tins are sunk in the ground to receive fæces; near by is a small round incinerator consisting of a circular wall three feet high with a grating across of iron rods and two air inlets below; dry litter and any dry material is put in, lit and it burns slowly; on this the material is incinerated. This is not always possible particularly in the trenches; but one battalion had an incinerator for its front line latrine; and where this can be done it is the proper thing.

2. Where incineration is impossible and deep trenching is impossible, then each latrine trench must be treated. After trying pesterine and fuel oil without effect, it was found that ordinary burning oil, as issued there, was effective; a trench treated with oil does not get infected with maggots and if oiled when it is filled up, many maggots are killed. There is much oil available, the crude lighting oil of the Anglo-Persian Oil Co., obtainable near Basrah, being quite suitable.

3. Oil should be used even with tins as it prevents flies settling and feeding on the excreta. A great deal of the diarrhœa and intestinal diseases prevalent must be carried by flies directly from the fæces of infected men and oiling prevents that.

4. Kitchen refuse and offal are to be burned or oiled and buried. This is obvious and is rendered more important by the fact that a great many goats are slaughtered by native regiments, in their own way, anywhere near their lines. There is a great deal of indiscriminate goat-killing going on wherever there are native units and this material would breed flies. The absence of blue-bottles shows how careful the men are in this matter.

5. Horse and mule droppings are to be collected and burned or spread out to dry. As a rule the droppings are wanted for the incinerators. The heat and dryness are such that in a very short time, house manure is too dry for flies to breed in it; the only trouble has been with the individual *saises* of officers' horses who

may be careless and breed a quantity of flies; where there are regular horse or mule lines the greatest care is taken.

6. Trial of fly poisoning with sodium arsenite showed it to be an extremely effective method; fortunately I had been able in Bombay to get 50 tins of weed killer, which was crude arsenite and worked very well.

A mixture is made of arsenite half a pound, *gur* two and a half pounds, water two and a half gallons. This is a convenient amount for a kerosene tin. In this a gunny bag was dipped and hung up. A shelter tent or a covering of mats is advisable or the flies will not come in the hot part of the day, and the gunny bag must be kept moist. Flies come in swarms, feed and die there on the spot. The solution is weak enough not to affect them till they have fed; if made too strong, they are affected before they get a fatal dose. It is possible to fit up strips of gunny on the roller towel principle so that it dips in the tin; as it dries and gets too concentrated water is added.

This simple poison, devised originally by Dr. Berlese of Portici, Italy, works beautifully; the flies are thirsty and hungry; they smell the *gur*, they come in shoals; blue-bottles come as well as *Musca*. The slaughter is very great and the effective range appears to be at least 200 yards and is probably much more. This means that to keep a camp clear one wants a fly-poisoning station every quarter of a mile or so. By having the poisoning done in a separate place there is no risk from dead flies and it is best to put the poison at a point between the latrines and the camp.

7. In the trenches flies collect in masses at certain places at night and at midday. They particularly like canvas or tarpaulin coverings and sheltered corners in dug-outs. With a spraying machine and suitable liquid, one can kill flies in bulk. The choice of liquid is easy; two only are at present known, both of which have been extensively used in Europe and Egypt since they were discovered last year. For the trenches we are using the oil-spray, a special grade of mineral oil to which is added a small amount of aromatic essential oil such as citronella. In England this is sold as "Flybane"; in Bombay, thanks to the help of the managers

of the Standard, Vacuum and Asiatic Oil Companies, the nearest grade of oil to that selected in England has been found and is being used.

8. Hospital tents and buildings require other methods. Formaline can be used for fly poisoning; but the "Miscible fly spray" used in Europe and Egypt will probably give the best results; it is undesirable to use the oil as it taints milk and food; but this new fly spray, whose laboratory name is *Exol*, is being sent up for hospital use. It is not poisonous or inflammable and has only a slight smell; it does not taint food. It is mixed with water and sprayed in the air. Flies fall to the ground paralysed or dead. It is not yet certain whether the formula used in Europe will succeed in Mesopotamia owing to the very high temperatures but this has to be ascertained and the formula varied if necessary. Thanks to the Medical Store-keeper at Bombay, large quantities of this have been made. At the request of the War Office the formula of this spray has not been published as the ingredients are not unlimited in supply. When the Army has had all it needs, the formula will be published and the public can get the liquid.

For hospitals, an ample supply of netting, mosquito nets, etc., has been essential. It is absolutely necessary to prevent flies getting at the excreta of cholera or dysentery patients for instance and in tents this is only possible with nets. In the same way the disposal of the excreta is very important and all field hospitals use incinerators.

A special problem arises in the case of bodies of men moving. I believe that it is better in these cases to have no trench latrines but to mark off a space of clean and hard ground and use that. The heat and dryness is such that flies cannot breed in the material which desiccates at once. This goes against the sanitary expert's ideas but I believe it to be sound in all cases where the moving body is not going to stay more than three days.

These are the methods recommended and the three important ones are—

(1) Disposal of fly-breeding material.

(2) Fly poisoning.

(3) Fly spraying in trenches and hospitals.

It was obvious that to carry these out there should be a special subordinate officer attached to each large camp and to each division. He would naturally be under the orders of the Sanitary Officer but his special business would be flies. He would inspect the whole of the camp or the trenches occupied by his division, hunt out fly-breeding material, report cases of bad sanitation, see that latrines are oiled. He would be in charge of the fly poisoning, he would show men how to use sprayers and organize a gang to systematically slaughter flies with sprayers.

Such work is best done by men used to spraying and similar operations. Eight were required for the different places in Mesopotamia and I proposed going to Pusa for them, taking volunteers from the Imperial Pathological Entomologist's Section, as flies have been their business for years, and also from other sections, or from Provincial Departments if necessary.

Captain C. F. C. Beeson, Imperial Forest Zoologist, who was with me in Mesopotamia, remained there and would be in charge of these men and the whole work.

This proposal was accepted and I returned to India to organize supplies of arsenic, sprayers, etc., and to get eight men. The selected men are shown in the photograph* which accompanies this article. They left Pusa on Wednesday, July 5th, for Bombay whence they proceeded to Basrah and Amarah. They were recruited from the entomological and mycological sections with one from the veterinary staff. They have rank as Indian Warrant Officers according to their pay and will be on duty in Mesopotamia probably till October. In the first place they join Captain Beeson to get experience of military conditions and then they will be posted out.

The Agricultural and the Forest Research Institutes are to be congratulated on supplying the officers and staff for this work. No one anticipated that the work of the entomological sections would be of vital use in this war, and it is a satisfaction that the work done years ago in the Imperial Department has been of

* Not reproduced.

direct use and that the men and methods can be supplied for the present campaign. Their work will be very much appreciated in Mesopotamia and we hope all will return well with a successful piece of work well done.

ENGLISH TIMBER

ENGLISH TIMBER.

The Earl of Selborne attended a meeting of the English Forestry Association, held at the Surveyors' Institution, Westminster, on Monday, 13th December, under the presidency of Sir E. Stafford Howard, and opened an interesting exhibition of British timber.

He drew attention to the need for the proper organization of English woods and plantations. He meant "organization" in the sense in which it had been applied by Sir Horace Plunkett in Ireland in respect of dairy and other farm produce. If English landowners and land agents would combine so that a real market price was obtainable for their wood, and show the railway companies that a reduction of rates would stimulate a trade which would pay them, and if they would learn to convert their existing woods into a more profitable form, and to conduct their planting on scientific lines, then, he believed, a great addition to the income of the soil would be found in Britain.

One of the immediate effects of the war had been an immense demand for forest products of various kinds. The greater demand had been for boards and scantlings for the erection of temporary buildings. Then there had been a big demand for pit wood. More English pit wood had found its way into the English coalfields in the last twelve months than had been the case in the previous twenty years. Yet the supply was inadequate to the demand, and prices were steadily increasing. The importation of timber for huts had been simply prodigious. An immense sum of money had gone out of the country for wood that might have been produced in this country, and this at the very moment when it was of national importance that the lowest possible amount of produce should be imported from abroad.

Rather late in the day, he admitted, the Government, a few weeks ago, appointed a committee to try to reduce this importation of foreign timber, and to try to organize all the sources of supply of British timber. The committee wanted landowners and agents to assist them, and they asked the landowners to allow the committee's agents to view their plantations to see what was available. Fir was the main article required, but there was also a very considerable demand for ash. The committee asked that the landowners should allow them to see their timber and make proposals for purchase, and if they agreed upon a price, he hoped the landowners would help in the conversion and haulage of the timber. The shortage of labour was a very special problem of the war, and it was so great they would be put to every kind of shift to fell and convert the timber. In many cases where there were existing saw-mills help could be given, and in most cases some little help might be afforded in the matter of haulage.

Replying to a question as to work on estates, Lord Selborne said he would not ask any of them to suspend or annul any ordinary transactions which they might think were for the benefit of their estates. He was not in a position to do that. He thought there would be plenty of room for the operations of the trade and the Government.

Sir Stafford Howard said that at the annual meeting of the association, held earlier in the day, a resolution was passed declaring that the greatest difficulty in procuring supplies of timber at present was that of securing labour for felling, conversion, hauling, and transport by rail ; and it was desirable that the Government should take steps, if possible, to meet the difficulty by giving assistance through the military, and allowing expert men to be brought back, or retained, for the work. Some encouragement should be given by the Government to landowners to replant.

In the course of an address on "English Timber; Before, During, and After the War," Mr. M. C. Duchesne drew attention to the strangely anomalous position of our native timber. Although we had one of the largest markets in the world in our midst, in some cases with tempting prices ruling, the demand and

the prices offered for our native oak—admittedly the best in the world—were extremely poor. It was a ridiculous fact that there were instances of English oak being sold as "Austrian oak," and our best Scots pine as "best foreign reds." Another curious anomaly was that, though architects and others in London wished to specify English oak for panelling and other work in building, scarcely a merchant in London was interested in pushing the sale of English oak for these purposes, so well organized and far-reaching was the marketing of foreign oak. Stranger still, although everyone admitted the unsatisfactory nature of the position, no one suggested any remedy, and whoever made an effort to improve matters experienced in many quarters not merely apathy, but even hostility.—[*The Field, The Country Gentleman's Newspaper.*]

DEATH DUTIES ON TIMBER.

The following is the text of a circular now being issued by the Royal English Arboricultural Society :—

The society are of opinion that it is advisable to call the attention of all landowners, their agents and solicitors, to the important provisions contained in Section 9 of the Finance Act, 1912 (2 and 3 Geo. V. ch. 8), relating to death duties on timber and underwood. Under that Act—

"Where an estate in respect of which estate duty is payable on the death of a person dying on or after the 30th day of April 1909, comprises land on which timber, trees, wood, or underwood are growing, the value of such timber, trees, wood, or underwood shall not be taken into account in estimating the principal value of the estate, or the rate of estate duty, and estate duty shall not be payable thereon, but shall, at the rate due to the principal value of the estate, be payable on the net moneys (if any) after deducting all necessary outgoings since the death of the deceased, which may from time to time be received from the sale of timber, trees, or wood, when felled or cut during the period which may elapse until the land on the death of some other

person again becomes liable or would but for this sub-section have become liable to estate duty."

The practical effect of this and the other Acts which it is not necessary to quote is that if an owner die leaving an estate worth £105,000, and the sale value of the timber on it is £10,000, his successor should only pay estate duty on £95,000. As long as he stands possessed of the land he will pay estate duty on such timber, trees, or wood only as he cuts and sells year by year, after deducting "all necessary outgoings," an expression in which the Estate Duty Office, according to their present practice, include expenses incurred in replanting timber ground which has been cleared or thinned out, so far as necessary to maintain the woodlands in the state in which they were at the death of the previous owner. No duty is payable on the money realized by the sale of underwood when cut, which escapes the payment of duty altogether, except when it is sold as part of the land. If the owner should sell the land he will be liable to pay the amount of death duty remitted, but if he should die no further sum will, under any circumstances, be chargeable against his estate in respect of the timber.

The effect of the Act is far-reaching: (1) because of the large amount of death duty that may be remitted; (2) because the deduction of the timber may bring the whole of the deceased's estate into a lower scale of duty.

In the case of (1) it should be remembered that timber often has two distinct values, which we may call "primary value" and "secondary value." The primary value is the price which the timber would fetch, apart from the land, and in the case of young plantations this value may or may not be reduced to nothing, according to the age of the plantations. The secondary value of timber is the value which is due to its ornamental character, its improvement of sporting, its usefulness for shelter and for shade or for other purposes. If a park contains timber of the primary value of £1,000, and the mansion and the park are let at £400 per annum on a repairing lease, the mansion and park may be valued for estate duty at £400 by 25 = £10,000. If the

property is valued in this way on a rental basis it is, in the majority of cases, correct to ignore the primary value of the timber for the purpose of the valuation, because the property would not command the same rent if the timber were felled, and the secondary value of the timber exceeds its primary value for the purposes of such a valuation. Although the primary value of the timber may have been ignored in making the valuation, it is in all cases correct to deduct it for the purpose of paying estate duty. In the above instance, the primary value of the timber (£1,000) may, therefore, be deducted from the valuation of £10,000, and estate duty paid on £9,000 only.

In the case of (2), if the first example be taken, if the timber were not deducted the successor would pay estate duty at the rate of 10 per cent. on £105,000, equivalent to £10,500, but if the timber be deducted it will bring the principal value below £100,000, and consequently into the 9 per cent. scale, and the duty payable would be 9 per cent. of £95,000, or £8,550 only.

It will thus be seen that there is a great benefit to be derived from the Act if advantage be taken of it. On the other hand, if it be neglected, not only will there be a serious over-payment of duty, but it will be assumed that the timber was taken into account at the time of the valuation, and whenever timber is cut death duty on that part will become payable a second time, and the attempt to recover the duty originally paid in error will, even if successful, involve the owner in a certain amount of trouble and expense.

It is always advisable to have the value of the timber at the time of the death ascertained and accepted as correct by the Estate Duty Office, because, if the timber is sold when growing, either as part of the land or separately from the land, duty is payable on the value of the timber as at the death, and not on its value as at the sale. Thus, if the first example be taken again and the timber be sold when growing for £15,000, either separately from or as part of the land, the owner will only pay duty on £10,000 instead of on £15,000. It will be obvious that in cases where there has been an appreciable increase in the value of the timber between the date of the death and the date of the sale, some part of the duty will

be saved if it is practicable for the owner to sell the timber when growing and allow the purchaser to cut it.

The above remarks relate to estate duty, but with one important exception they also relate to succession duty, an additional duty which, generally speaking, is payable in all cases except in the case of small estates inherited by lineal ancestors or descendants of the deceased. The exception referred to is that the rate of succession duty payable varies from 1 per cent. to 10 per cent., not according to the value of the estate, but according to the degree of relationship between the deceased and the successor.

Further copies of this circular may be obtained or information will be given on application to the Secretary, The Royal English Arboricultural Society, Haydon Bridge, Northumberland.—[*The Field, The Country Gentleman's Newspaper.*]

SOME USES OF PRICKLY-PEAR.

The prickly-pear plant is considered by many ryots as a curse to the country, as it has overrun immense areas in several villages. In some places, much agricultural land has been rendered temporarily useless from having been taken possession of by this troublesome pest. In very many villages, the scrub jungles are overgrown with it and the land which would have otherwise been useful for growth of trees and grasses is occupied by it. It forms a safe refuge for snakes, etc. By the spread of this plant several public thoroughfares are becoming narrower every year, whilst poramboke lands are not infrequently rendered useless thereby for any purpose. The ground close to these bushes is used as a public latrine by villagers which encourages the growth of the plant and does not add to the amenities of the village. The eradication of prickly-pear in villages is therefore one of the serious problems with which ryots have to contend.

Although attempts are being made here and there by public bodies such as taluk and district boards to eradicate this plant in very congested areas, yet such work is only practicable on a large scale if ryots in all the villages assist in removing it.

In parts of Coimbatore district, prickly-pear is used after decomposition and composting as a manure for dry land crops such as cumbu, cholam, dry ragi and garden crops like ragi, chillies, tobacco, wheat, plantains, sugar-cane, etc. This is, however, not resorted to by all. In many cases it is prickly-pear growing in corners of their fields or extending from outside into the fields that is cleared and composted by way of disposal. A few ryots compost prickly-pear especially when it is abundantly available near at hand ; but this is not followed as much as it might be.

Ryots, however, have taken up to the practice of carting to their fields the earth which accumulates under prickly-pear bushes for improving their lands. In tank, bunds and porambokes, nothing is paid for the earth itself, and the cost is only two annas per cart-load (when the distance to be carted is about half a mile), for clearing the prickly-pear to get at the earth beneath, digging the earth, loading and carting it to the fields. The price per cart is becoming higher gradually owing to the increased wages. The soil under the prickly-pear bushes is of high manurial value as it is very largely composed of leaf mould and other organic matter blown in by the agency of wind. Prickly-pear itself contains more than 60 per cent. of organic matter (Dr. Leather's analysis) and if such a substance is composted with the rich soil found under these bushes the manurial value will certainly be enhanced. Many of our soils are deficient in organic matter, and if a compost of prickly-pear and the soil found under it is made and applied, the result will be beneficial. By composting prickly-pear, ryots not only obtain manure but get rid of this pest which is at present a nuisance in many respects.

The following methods may be adopted for composting :—

(1) A trench 3 feet to 4 feet deep and 6 feet broad of any required length may be dug and kept ready during the interval between the first and second monsoons. During rainy days when the ryots have not got busy work, prickly-pear may be cut, removed and filled in the trench and covered with soil that has been removed in digging it. The top of the trench will sink after some days owing to the decay of the stuff and at this stage the soil

from under the removed bushes may be dug and thrown on the top. In places having good rainfall, this will make a good compost within one year. If the thorns have not decomposed thoroughly, this may be left for another year when the thorns also will decompose.

(2) In regions of scanty rainfall, prickly-pear may be removed and heaped up in convenient mounds and allowed to dry up during seasons when ryots have enough leisure at their disposal. Dried bushes, grasses and other rubbish procurable in the vicinity may be spread over the heaps and set fire to. The thorny substance is partially burnt. At this stage the earth removed from under the bushes or from lands close by should be spread all over the heap which can then be left for some years until decomposition is complete. In three or four years, this will be fit for being carted to fields.

(3) If space is not available for the above, circular constructions similar to those used for grinding chunam should be made. The prickly-pear is then thrown into this pit and ground by a stone grinder just as chunam is ground. Owing to the large amount of water in the stems the plant, when the stuff is ground, is converted into a jelly-like substance within half an hour and the whole mass can be removed by mamuties and carried to places where compost is to be made. If this is filled in pits or covered with some earth, decomposition will easily set in. The thorns also will not stand erect but will lie flat and the nuisance they cause will be much reduced. In this case the manure will be ready within six to eight months.

Prickly-pear can also be used to serve other useful purposes than the one above referred to. The water obtained after boiling prickly-pear for some time can be used as a drier in white-washes. An ordinary pot or chatti is filled with prickly-pear cut into small pieces; as much water as the pot will hold is then added. The whole is boiled for about three hours and stirred during the process. When cool, the liquid is strained and added to separately prepared white or colour-wash in the proportion of 1 to 150 or 160. White-wash or colour-wash treated in this way becomes fast and does not

rub off easily. In Indian houses this fast colour is a great advantage as it does not soil the clothing or body when the newly white-washed walls are touched.—[*Government of Madras, Revenue Department, G. O.* No. 1151, *dated* 20*th May* 1916.]

DISTILLATION OF SANDALWOOD OIL.

EXPERIMENTAL FACTORY AT BANGALORE.

Mr. Alfred Chatterton, C.I.E., Director of Industries and Commerce in Mysore, writing to the *Mysore Economic Journal* on this subject, states that the disposal of sandalwood in Mysore is a State monopoly which in recent years has produced a large net revenue. In 1913-14 just previous to the outbreak of war this revenue amounted to 19·87 lakhs of rupees produced by the sale of 1,862 tons of wood. The wood is mainly disposed of by auction sales held in months of November and December, but after the outbreak of war there was an almost complete cessation of the demand from European buyers. Latterly the business has revived and at the auction sales at the end of last year good prices were obtained for a fairly large quantity of wood. It is only the heart-wood of the sandal tree that is of great commercial value. In a small way it is used for wood-carving; but the high prices which the wood fetches are due to the fact that it yields an oil very largely used for medicinal purposes and in the preparation of perfumery.

"The extraction of the oil from sandalwood is not permitted to private persons in the Mysore State; but the industry is to some extent carried on round the borders of the State, especially in the South Canara district. It is also largely manufactured at Kanauj in the Punjab, where the oil is principally used in the preparation of sweet scented essences. So long as the State was enjoying a steadily increasing revenue from its sandalwood monopoly it was obviously undesirable to disturb the existing arrangements; but when the market for sandalwood collapsed at the end of 1914, it became necessary to consider what steps should be taken to preserve this valuable source of revenue.

"The users of sandalwood oil in Europe and America either distil their own oil or purchase from chemical firms of repute. Oil of Indian manufacture is unsaleable because of the defective methods used in the distillation and the tendency to adulterate it with innocuous cheap oils. Very little was known about the methods of distillation employed in the West and as a preliminary to any proposals to set up sandalwood distillation in Mysore, it was decided to have the whole question thoroughly investigated and this work was entrusted to Professor Sudborough and Dr. Watson of the Indian Institute of Science. During the whole of last year and up to the present time the matter has been under experimental investigation and the *results obtained are of a sufficiently satisfactory character to warrant the establishment of an experimental factory* where the oil will be manufactured on a commercial scale. This new factory, which will cost about one lakh of rupees, is now under course of construction on the Tumkur road to the north of Sankey's tank on a piece of land between the tank bed and the property of the Indian Institute of Science. In the course of the experimental work, a considerable quantity of sandalwood oil has been produced, the bulk of which has been sold locally at very favourable prices and the oil which has been sent to England has been declared equal to the best that can be obtained in Europe and has fetched equal prices. Owing to the war it has been found impossible to get machinery or plant from Europe and the same is in consequence being made in this country. This unfortunately entails delay; but it is hoped that by the end of March the new factory will be at work producing about 2,000 pounds of sandalwood oil per month. The oil produced with the experimental plant is now selling freely at Rs. 18 per pound whilst the price on the London market is as high as 30 shillings a pound. To pass the test to which the oil is subjected in Europe complete chemical control is necessary, and every consignment of oil sent out from the factory will be subjected to an examination and a certificate as to its quality issued. In this way it is hoped that we shall be able to overcome the prejudice against the sandalwood oil manufactured in India and we shall be able to

retain in the Mysore State the profits on the manufacture of the oil which have hitherto largely gone to Germany.

"Although sandalwood oil has been manufactured in India from time immemorial, this venture is practically a new industry as the methods to pursue are from the beginning entirely different from current Indian practices. The annual auction sales of sandalwood will still continue and the new factory will purchase sandalwood from the Forest Department at the same prices as paid by outsiders. If the industry proves profitable, as it surely will, it is under contemplation to establish a distillation plant of sufficient size to deal with the whole annual output of the sandalwood in the South of India. The advantages possessed by a local distillery worked on modern lines are very considerable, and it is expected that not only will we be able to maintain the revenue hitherto enjoyed from the sandalwood monopoly but to largely increase it.

"The experimental factory has been located near the Indian Institute of Science to take advantage of the facilities available there for research work. A plentiful supply of water can also be obtained for the condensers; but in respect to fuel, of which large quantities will be consumed, it is not a favourable site as the cost of firewood in the neighbourhood of Bangalore is high. When the experiments on a commercial scale are completed and it is possible to design a thoroughly up-to-date modern factory, the work will be developed at some site where firewood for fuel is cheap and there is ample water-supply. At present it seems likely that these conditions will be best fulfilled in the neighbourhood of Shimoga."—[*The Indian Trade Journal.*]

KAING GRASS OF BURMA.

The possibilities of utilizing the Kaing grass of Burma for paper-making have for some years past been investigated by persons interested, in consultation with paper manufacturers in this country, and it is now announced that the conversion of this grass into pulp and subsequently into paper, can be accomplished in a simple and economical manner. It is expected that arrangements

will soon be completed for the collection of the grass, its conversion into pulp, and its shipment in this form to paper-makers in the United Kingdom. The yield of unbleached pulp is 39 per cent., calculated on the air-dry grass. This does not compare badly with esparto grass, from which about 43 per cent. of unbleached pulp is obtained. Kaing grass grows in great profusion in all parts of Burma, frequently reaching a height of ten feet. As a paper-making material it may be classed with esparto grass, and is much cheaper, though the quality of the pulp is not quite so good as that obtained with esparto. Esparto grass is to a large extent cultivated, whereas Kaing grass grows wild and is sometimes rank and coarse. By systematic cutting, however, over properly preserved areas, a finer grass of uniform quality can be obtained in a very short time.—[*Paper Trade Review.*]

FOREST FIRES TO BE PREVENTED BY WIRELESS.

Philip E. Edelman of St. Paul, Minn., a recognized writer and authority on wireless subjects, has been engaged as electrical engineer to prepare plans for a chain of radio stations to protect the vast Dominion of Canada Parks from forest fires and depredations. The Canadian Government has extensive areas in Western Canada where communication is extremely difficult, and will use equipment of a new and special design. This will be the first installation of its kind, and opens up a new field for the application of radio telephony and telegraphy, both of which forms of communication are embraced in the plans of Mr. Edelman. The stations will be used to report fires and poachers as soon as discovered, so that aid can be immediately sent to the vicinity concerned.—[*Scientific American.*]

VOLUME XLIII NUMBER 2

INDIAN FORESTER

FEBRUARY, 1917.

THE DISTRIBUTION OF THE SAL IN THE RAMNAGAR FOREST DIVISION.

BY S. H. HOWARD, I.F.S.

There are in the Ramnagar Division four types of Sal forest:—

(*a*) The forests of the Jaspur Range.

(*b*) The forests of the Malani and Dhara ranges, with which may be included the Gaujpani block of the South Patli Dun Range.

(*c*) The well-stocked and comparatively pure Sal forest of the Duns.

(*d*) The rest of the Division.

Of these four, section (*a*) is situated on the Terai* and Bhabar* and is far more on the latter than the former. The observations and conclusions in this article are not meant to apply to those

* [In case the terms Terai and Bhabar are unfamilar to my readers it may be explained that both are recent deposits. The *Bhabar* is a dry waterless tract extending from the foot of the hills some six to eight miles into the plains with a very permeable subsoil composed of Himalayan detritus. The *Terai* is a swampy belt extending some miles south from the Bhabar. The water from the Himalayas sinks through the permeable Bhabar and reappears in the Terai to join the swamps. A distinct line of springs often marks the boundary between the two.—HON. ED.]

forests. Probably they do apply to a great extent, but as they are not included in the recent plan of the Ramnagar Division made by the writer, observations have not been made there in the same detail as in the rest of the tract. Section (*b*) is situated almost entirely on the crumbling Middle Siwalik Sand rock, except for a small patch near Kalagarh where the Nahan Sandstone crops out, and a narrow belt of Upper Siwalik Conglomerate near the northern boundary. All this section is being rapidly denuded and the forest is of extremely poor quality. The percentage of Sal in the crop is very variable and this section will be protected during the next twenty years and at the same time subjected to fellings, the object of which will be simply to improve the crop.

It is over sections (*c*) and (*d*) that the data were mostly collected on which this article is based. The conclusions apply equally well to section (*b*), but as there are fewer Sal there, it is not at present of the same importance.

SECTIONS (C) AND (D).

These two sections are situated entirely on Upper Siwalik Conglomerate and Nahan Sandstone and far more on the latter than on the former. The purest and most regular Sal forest occurs on the better drained portions of the Upper Siwalik Conglomerate, and practically the whole of the area which is to be treated under the Uniform system is situated on this rock. On the whole, however, the Sal on the Nahan Sandstone is the better quality.

The area occupied by these two sections is the major portion of the Division, and is mostly hilly country, facing in all directions, of varying altitudes and cut up by deep ravines. Steep slopes alternate with rounded ridges and small plateaux, small flats occur in valleys, and in places the country is undulating. In addition to this there are the large flats of the Patli Dun, between Boxar and Sarupduli, a series of comparatively large and gently sloping chaors between Gairal and Garjia (including a flat behind Mohan), and the Kotah Dun flats in the Kotah Range.

All classes and qualities, both of soil and crop, exist. The crop varies from almost pure Sal to areas containing practically nothing

but inferior species; from well-grown, straight-boled, sound trees with good crowns to stunted, hollow and ragged specimens; the soil varies from bare sandstone rock to stiff deep clay and in fact every possible combination occurs, sometimes in the same compartment.

Sal regeneration is sometimes entirely absent and at others covers the ground like a carpet. On the whole the crop may be said to be a mixed one with a fair proportion of Sal of all ages. It is, however, a very striking fact that there is a remarkably large proportion of poles and saplings. These usually occur in groups, seldom singly, and it is noticeable that the quality of these saplings is usually superior to that of the older trees in the immediate neighbourhood. In some cases this is, no doubt, partly due to the fact that former fellings removed all the good trees and left all the bad ones, but this does not account for everything. Many of these areas have only been subjected to Improvement fellings and the better quality and stocking of the young crop is equally noticeable there. This improved state is probably partly due to the fact that these younger trees have sprung up since the area has been under the care of the Forest Department, and partly that the Sal grows better in an even-aged group with full access to top light than as a single tree struggling in a virgin forest. Creepers on the whole do a certain amount of damage in this section, more especially among the saplings and poles.

With regard to the proportions of age-classes (or girth-classes) it is difficult to say anything more than that all ages exist.

From enumerations made over 26,161 acres of these forests (and which the writer will guarantee as correct to within less than five per cent.) it is found that the following proportions of Sal exist :—

3′—4′	4—5′	5′—6′	Over 6′
551	287	137	100

In the Haldwani Plan the figures estimated from an enumeration made by Mr. Hearle are—

418	279	140	100

As the stocking of a normal Sal forest is at present unknown it is impossible to say whether these proportions are correct or

otherwise. The following statements can, however, be made with safety :—

(i) the number of trees below three feet in girth is proportionally in excess ;

(ii) taking all species and all age-classes the forests are much understocked ;

(iii) the proportion of Sal to other species is far smaller than it should be. Many areas in which there is at present only a small percentage of Sal could be made to hold almost pure Sal forest.

From the very variable forest briefly described above supplemented by observations in section (*b*) the writer attempted to observe in a general way—

(*a*) how the Sal is distributed, and to deduce therefrom ;

(*b*) what governed the distribution.

HOW THE SAL IS DISTRIBUTED.

The first point that strikes any one inspecting these forests in detail is that, as a whole, the typically south and east aspects are stocked with Sal of much poorer quality than the north and west aspects, although the proportion of Sal frequently appears to be greater on the south and east aspects.

On the south aspects there is usually a steep sudden drop followed by a móre gentle slope and on north aspects a more uniform gradient. On steep ground with a south aspect the Sal is found in least proportion, in fact there is often none at all. The whole crop is moreover often open and poor and any Sal occurring are usually stunted, short-boled and probably physically mature at a very low girth, often not over four feet. The species found besides Sal are—

Trees and Shrubs—

Terminalia tomentosa (sein).
Ougeinia dalbergioides (sandan).
Anogeissus latifolia (bakli).
Lagerstrœmia parviflora (dhaura).
Semecarpus Anacardium (bhilawa).

Buchanania latifolia (kathbhilawa).
Eugenia Jambolana (jaman), rare on these places and always thin, poor and stunted.
Cassia Fistula (amaltas).

Schleichera trijuga (kusam)	sometimes	These are common on low-lying ground, stony river-beds, etc.
Butea frondosa (dhak)	"	
Adina cordifolia (haldu)	"	

Diospyros tomentosa (tendu).
Odina Wodier (jhingan).
Phyllanthus Emblica (aonla).
Ehretia lævis (chamror).
Bauhinia malabarica (amli).
Zizyphus xylopyra (kathber).

Lianes—
Bauhinia Vahlii (maljhan).
Millettia auriculata (gauj).

Bamboos.

There may or may not be Sal mixed with the above species. As a rule there will be a few Sal, often as many Sal as any other single species, but the crop as a whole is miscellaneous. If there are no Sal then usually nothing but Bakli, Sandan, Amaltas and a few Khair will be found, but this as a rule only occurs on the hottest and driest slopes. On rounded ridges at this aspect, where the soil is usually deeper and stiffer, Tendu often appears, but under such conditions the Sal, though poor and stunted, is as a rule in much larger proportion.

At south aspects, however, wherever for any reason the soil is a little deeper and better, the Sal increases in proportion, seems to hold its own and reproduction, though of poor quality, is often plentiful. On the dry, hot southern slopes the Sal, both young and old, are almost always poor and stunted.

As a lower altitude is reached, the slope usually becomes more gentle and the proportion of Sal increases, it is better grown and may or may not regenerate freely. The soil is, as a rule, deeper and has a larger admixture of decomposed organic remains ; it

becomes often a loamy sand or sandy loam, in place of the sand or clay of the ridges and steep slopes. At a still lower altitude, as the slope gets shaded by a neighbouring hill, the locality is no longer exposed to the hot sun all day, the soil becomes deeper and better and the Sal continues to improve in quality and quantity.

Once however the actual valley is reached where it is shady for much of the year, the soil often loam, and the climate moist and cool, another change occurs. The Sal in such places is usually very finely grown, of excellent quality, with plenty of young seedlings. It may or may not be pure however. Often in the neighbourhood of streams and in these sheltered valleys the Sal is mixed with an entirely different type of vegetation. The species found are—

Trees and Shrubs—

Eugenia Jambolana (jaman).
Mallotus philippinensis (ruini).
Mangifera indica (mango).
Trewia nudiflora.
Machilus Gamblei.
Cedrela Toona (tun).
Terminalia tomentosa (sein).
Phœbe lanceolata.
Bischofia javanica.
Salix tetrasperma.
Putranjiva Roxburghii.
Ficus retusa.
,, *glomerata.*
,, *palmata* (small tree).
Olea glandulifera.
Celtis australis (sometimes).
Musa sapientum (wild banana)
Debregeasia (species not noted).
Callicarpa (,, ,, ,,)
Citrus medica.
Coffea bengalensis.

Lianes—

Smilax.
Clematis.
Sabia paniculata.
Calamus tenuis.
Ficus scandens.
Hiptage Madablota.

Moreover, on the hot south slopes the only undergrowth is composed of the regeneration of the species forming the overwood or of grass and there is no humus. In this valley vegetation undershrubs such as *Ardisia humilis*, *Glycosmis pentaphylla*, sometimes *Clerodendron* and masses of ferns and mosses occur. Epiphytes are unknown on the hot south slopes, whereas in the moist valleys epiphytic orchids, etc., are common.

The Sal is practically always well grown but, except when pure, has the appearance of a coppice-with-standard forest, that is to say, the Sal appears as a scattered overwood over a dense mass of the miscellaneous species mentioned above. If the ground under this underwood be examined numerous Sal seedlings can often be found, but apparently they find great difficulty in penetrating the dense mass above them.

Turning now to the north and west aspects, it is found that the type of forest with few Sal and species such as Bakli, Sandan, etc., exists in much smaller proportion and even what there is of it contains a larger percentage of Sal than the same type on the south slope with the same gradient.

The conditions over all the upper parts of the north slopes approximate to the more sheltered portions of the south aspects, and it is on these north aspects that much of the purest of the hill Sal occurs. There is, however, on these north slopes a far larger proportion of the type of forest described above as the valley type. It extends much further up the hill on the north slopes often reaching almost to the top in depressions.

The result is just the same as described before, namely, that, although what Sal there are, are often extremely fine specimens,

they are scattered and their seedlings find great difficulty in penetrating the dense undergrowth.

In some of the valleys with a north aspect (along the Nauni nala), in addition to the moisture and shade, a stiff clay soil occurs. On stiff clay the Sal is always of poor quality.

The Sal seems to avoid a pure limestone soil. In Compartment 11, Haldgadi Block, there is a sharp line dividing limestone from sandstone which the Sal follows absolutely. On the sandstone the Sal is almost pure, whereas on the limestone it is practically non-existent and Euphorbias and other xerophytic species occur. This statement is, however, only true of a soil produced *in situ* over limestone. In other cases, where there is simply a certain admixture of limestone, it appears to be beneficial. The writer cannot say whether the presence of this percentage of limestone does improve the soundness of the Sal, as in all cases where comparisons might be made there are other factors which might account for it. Nor, conversely, can it be said that it is the presence of limestone which is the cause of the absence of Sal in the upper parts of Compartment 11, Haldgadi Block, and similar places. All the species in such places are most xerophilous in character and the writer is inclined to think that the entire absence of Sal is not so much due to the presence of lime as to the physiological dryness of the soil—a characteristic of all these pure limestone areas.

The above gives fair summary of how the Sal is distributed.

THE CAUSES WHICH GOVERN THE DISTRIBUTION OF THE SAL.

Plants adapt themselves to their environment and the better the adaptation the more chance has that plant in the struggle for existence. The adaptations take many forms which it would be out of place to go into here but, among other things, plants have to adapt themseves to the water-supply, temperature, light, etc. If a plant is transpiring actively when an insufficient water-supply is being obtained by its roots that plant wilts and in extreme cases dies. If then one plant by its adaptations can transpire less

actively at certain times than another, then, on the whole, that plant stands a better chance of surviving, when the water-supply is precarious, than one actively transpiring the whole time.

Plants have been œcologically classified in various ways.

Warming divides land plants into two main classes :—

Xerophytes = Practically desert plants.

Mesophytes = The rest.

Warming's Mesophytes would thus include practically everything in the Ramnagar forests except such plants as the Euphorbia.

It is necessary, however, to sub-divide the Mesophytic formation in order to follow the distribution of the Sal. Schimper classifies land plants as—

Hygrophytes = (For practical purposes) evergreens.

Tropophytes = Deciduous.

Xerophytes = desert plants.*

It is unnecessary to enumerate the characteristics of these formations. For the purpose of following the distribution of the Sal in the Ramnagar Division (above the sub-montane road) the above-named three types can be distinguished, but it must not be imagined that the types are as sweeping as Schimper's types, for whereas his was a classification of the world's vegetation this is applied only to the one small place. For instance, there is really hardly any Hygrophilous forest as Schimper understood it, but there is forest which tends towards it and which has many hygrophytic adaptations. Species may occur in more than one type and may only be mentioned for one, but in such a case that species is typically found in the type to which it is referred.

(*i*) *Hygrophilous Forest.*—This can be very easily recognized. The general effect is that of an evergreen forest with dense luxuriant foliage. Many of the actual individual species are deciduous ; still, if this type be examined as a whole in any month of the year, the general impression conveyed is that the foliage is abundant. General characteristics which may be noted are the dark green colour of the leaves, the frequent occurrence of drip-points, and the fact that most of the foliage is ombrophilous.

* Warming's Œcology ; Schimper's Plant Geography ; Hole's Œcology of Some Indian Grasses.

Epiphytes are common, woody lianes are numerous and often form an almost impenetrable mass, ferns and mosses cover the ground, etc., etc. The common species are all those mentioned above as occurring in the moist, sheltered valleys. In this type, provided the soil is deep enough, the Sal, though scattered, is of excellent quality, producing the best timber in the division. The number of Sal per acre, however, is often less in this type than in the others.

The extreme hygrophilous type occupies a comparatively small area, usually on very sheltered northern aspects and in the neighbourhood of streams. Examples may be found in the Haldgadi Block near the Haldgadi Sot, in the lower parts of the Mandal Block, along the Adnala, especially on the left bank, etc.

(*ii*) *The Xerophilous type.*—In its extreme form this type can be as easily recognized as the hygrophilous forest. The general characteristics are the almost entire absence of Sal, a generally open forest, the fewness of lianes (only Gauj and Maljhan), the absence of epiphytes, ferns, etc. Drip-points do not occur, the foliage is less luxuriant and it is ombrophilous. Numerous species may occur but the most typical are Bakli and Sandan with *Lagerstrœmia parviflora* and *Cassia Fistula* often present. For this reason the type can be recognized at once in the cold weather by the red of the Bakli and the almost yellow colour of the Sandan and in the hotter weather, March and April, by the general leafless effect.

Typical examples can be seen in Compartment 6, Kunkhet Block, and on almost any hot steep southern slope. In its extreme form this type also occupies a comparatively small area, but a large area approaches the xerophilous type where, in addition to Bakli and Sandan, there are also present Sal, Sein, Bhilawa, Kathbhilawa and Tendu, the percentage of Sal depending on how far the area is removed from the extreme xerophilous type. Wherever Sal occurs in this type, both in its extreme form and where the additional species like Bhilawa, etc., occur, it is of poor quality, gnarled, short-boled, frequently hollow and physically mature at a low girth of 4 ft. or 4 ft. 6 in.

(*iii*) *The Intermediate type*.—Midway between the above two extremes large areas occur where the Sal is either pure or at any rate forms the largest element in the crop. Miscellaneous species, when present, are of secondary importance. As examples may be cited most of the lower slopes of the Dhikala forests, the lower hills on the right bank of the Ramganga, areas near the Paniali Gadh, parts of the Kailkhur, Lachampur and Patkot blocks.

The quality of the crop varies greatly depending on the quality and depth of the soil. Excellent Sal occurs in the Lachampur Block, extremely poor Sal in much of the Champagadh Block, yet both really belong to this intermediate type.

This type passes gradually into the xerophilous type in the one direction and into the hygrophilous type in the other, and it really occupies far the largest proportion of the division. This does not mean that most of the division contains pure Sal forest but that most of it is covered either by pure Sal forest, mixed forest of Sal with the more xerophilous species such as Bhilawa, Bakli, etc., or mixed forest of Sal with the more hygrophilous species such as Ruini, Jaman, etc., Sal being the predominating species.

In order to follow the characteristics of the Sal in this division the following attempt is made at determining the influence of the commonest factors on the Sal :—

Gradient.—Gradient of itself seems to have practically no effect on the distribution of the Sal. Provided other conditions are favourable it seems to grow equally well on almost any gradient. Gradient does, however, affect it in so far as it affects the factors of soil and moisture. On the whole steep gradients have a shallower and drier soil than gentle slopes and consequently fewer and poorer Sal. Flat areas also, if low-lying, tend to become water-logged and are then often devoid of Sal, but it seems to be the factors of soil and moisture which directly affect the question and not the gradient.

Aspect.—Aspect of itself, like gradient, seems to have little or no effect on the distribution and growth of the Sal. It has, however,

a very important indirect influence in so far as it affects the factors of light and heat and thereby soil and moisture. Given the proper soil and moisture conditions, Sal seems to grow equally well on any aspect. On the whole, however, the southern slopes, bearing the full brunt of the monsoon and being fully exposed to the sun, are steeper at higher altitudes and more undulating lower down than northern slopes. This usually results in an extremely shallow and dry soil at the higher altitudes on south slopes, giving the xerophilous type of forest or tending towards it. On fairly steep slopes the soil will usually be deeper and fresher on the northern slope than on the southern, and consequently there will be more Sal and of better quality on the northern slope. On gentle slopes, where the soil is deep, the moisture on the north slope gives rise to the hygrophilous type with fine but comparatively few Sal. An equivalent locality on the south slope is drier and instead of the hygrophilous type, an almost pure Sal crop would occur. It is, however, not the aspect itself which is the deciding factor but the soil and moisture, aspect merely influencing these two factors because it influences light and heat.

Light.—Presumably there is a maximum and minimum intensity of light beyond which the Sal cannot grow. This, however, does not affect this forest. There is nowhere in the tract where the intensity of light is below the minimum or above the maximum, provided the tree can enjoy the full intensity of light falling on the area. The shadiest northern slope is light enough for excellent Sal and the sunniest southern slope is not too light. There is probably enough difference in the intensity and duration of light on north and south slopes to make a difference in the rate of growth, but that is a minor point for the moment. It is only trees, however, which have the leading shoot fully exposed to top-light and side-light, which do enjoy the full intensity of light falling on an area. This can be very simply tested by taking a photograph inside and outside the forest. It will be found that on the same slope four or five times the exposure is needed inside the forest and in extreme cases eight or ten times. It is surprising how much light is cut off by even a thin leaf-canopy.

This has a large effect on the growth of trees in a selection type of forest where young trees grow up under the shade of the old, and the rates of growth of Sal under the shade of other trees and with their leading shoots free is surprisingly different.

The nearer the ground, the more light is cut off, so that the young seedling is most affected.

In the hygrophilous type of forest this is probably one of the reasons for the small number of Sal. In the intense shade near the ground in such forests, the young Sal does not get enough light to grow and, being a light-demander, it is very easily beaten by its more shade-bearing competitors, although it must be remembered that a Sal seedling will bear far more shade than a Sal pole. There are many factors detrimental to young Sal in the hygrophilous type but lack of light is one of them.

Heat.—Like light, there is probably a minimum and maximum intensity of heat, outside which the Sal cannot grow. Also like light, however, it does not affect this tract. The coldest places are warm enough for Sal and the hottest places are not too hot. Frost damage is quite a different point and, it may be remarked in passing that, the worst frost damage in this tract does not occur in the coldest places. Heat and light are more or less dependent on one another, and in a general way it may be said that the intensely light places are also intensely hot, although other factors do sometimes modify the heat in the light places. Although there is always enough heat for Sal—and never too much—still heat plays a large part indirectly in the distribution of the Sal in so far as it affects the question of moisture. Other conditions being equal, hot places are dry places.

Soil and Moisture.—The "climatic factors" such as light, heat, rainfall, etc., are of little or no importance in determining the distribution of the Sal within the division. These factors are of primary importance in determining whether the Ramnagar Division falls within a tract with a "Sal climate." It does fall within the Sal tract and, although perhaps not in the optimum climate for Sal, there is no more to be said. Topographical features likewise are of little or no importance directly. Indirectly they are of some

importance in so far as they produce modifications in the climate causing it to approach more nearly to or depart farther from the optimum Sal climate, and they are of great importance in so far as the soil and moisture conditions are modified by them.

Soil and moisture seem to be the only primary natural factors governing the distribution of the Sal within the division.

To a great extent these two factors are inter-dependent. At a given aspect and gradient deep soil will usually be moister than shallow soil, and on good loam or sandy loam the moisture condition will usually be better than on stiff clay or sand ; the clay is inclined to be water-logged in wet weather and baked in dry and the sand is usually too hot and dry in the hot weather.

A certain minimum depth of soil is absolutely essential for Sal to grow and it is absolutely essential that the soil be well drained. This minimum is usually present and the soil over almost all the hilly portions is well drained.

Given the minimum depth, however, it seems to be the moisture conditions (of soil and atmosphere) far more than the depth and quality of the soil which governs the percentage of the Sal. It is difficult to prove this point. If, however, the whole ridge near Kanda bungalow be examined on both the north and south face, it will be found that the depth and quailty of the soil is much the same over a large part. The factors which differ are heat and light and these, reacting on the moisture, cause the north slope to be far moister than the south, and it will be seen that there are far more Sal on the north slope. This point, however, is complicated because the intensity of light under a canopy of trees may be insufficient for Sal seedlings but sufficient for the more hygrophilous species ; moreover, the thick and often acid humus absorbing and holding stagnating water, and the bad aeration of the soil produce conditions in the moist areas quite unfavourable to Sal seedlings. Given sufficient moisture, the hygrophilous species will effectually oust the young Sal, which is exactly what has happened in many of the moist places. This is not, however, because the soil and moisture conditions in such

localities are unfavourable to Sal, either young or old, but because these conditions are so favourable to the hygrophilous species that they flourish and then produce surface soil conditions unfavourable to Sal seedlings.

On the other hand, in the driest parts, even with moderately deep soil, the Sal finds great difficulty in living. Here again it is in the germinating and seedling stage that the mortality occurs. This question has nothing to do with the climatic factor of rainfall. The rainfall is sufficient for Sal; it is drainage, percolation and evaporation which causes the scarcity, and this is naturally worst on the high, steep, south slopes especially if the soil is shallow—an example of the topography modifying the climate.

Although, however, moisture seems to be the more important factor as regards the distribution and percentage of the Sal, it appears probable, given the necessary minimum of moisture, that the depth and quality of the soil are the factors influencing the growth and quality of the Sal. Good deep loam or sandy loam will produce long-boled, well-grown Sal, but no amount of moisture will produce such Sal on a poor shallow soil.

Conclusions.—(1) Given a "Sal climate" it is the soil and moisture conditions which influence the quality and distribution of the Sal. Other factors are only of influence in so far as they modify soil and moisture.

(2) The Sal will not grow where the soil is badly aerated or water-logged.

(3) Given a well-drained soil of good depth and quality, however, *the moistest places in this division will produce the best Sal.*

As an example, along the Haldgadi Sot above Mundiapáni the comparatively rare combination of a good deep well-drained soil with excessive humidity occurs. Naturally under such conditions there are numerous hygrophilous species in the crop. What Sal there are, however, are among the very finest in the division.

(4) The Sal seems to stand midway between the hygrophilous and xerophilous species as here classified. It can therefore

probably grow over a greater range of moisture conditions than either of the other classes. Therefore—

(*a*) in the hygrophilous type the conditions are very suitable to Sal, but it is liable to be ousted by the more hygrophilous species. The removal of these species and the admission of more light would probably produce an excellent crop of Sal;

(*b*) in the intermediate type the Sal holds its own against both the more hygrophilous and the more xerophilous species;

(*c*) in the driest places the Sal, although able to grow, is liable to be ousted by the more xerophilous types. An increase in the density of the crop improving the soil and moisture conditions would probably produce a better crop of Sal.

THE ISSUE OF TIMBER LICENSES IN BURMA.

BY H. C. WALKER, I.F.S.

In Burma licenses are prepaid. For instance, a timber trader wishing to extract 100 tons of *pyingado* at Rs. 5 a ton has to pay the whole amount of duty, namely, Rs. 500, before he is granted a license or is allowed to extract any timber. The money to pay this duty is almost invariably raised by a loan from a money-lender who charges a high rate of interest, usually 3 per cent. per mensem. We should prefer timber traders not to work on borrowed capital. From our point of view it would be more satisfactory, and it is not improbable that his profits would be equally great if a trader instead of attempting to work out 199 tons of timber on borrowed capital were satisfied to work out 50 or even only 25 tons with his own capital. However, we must take the Burman as we find him, and the fact remains that practically the whole of our revenue on prepaid licenses is supplied by money-lenders. Indebtedness is not confined to timber traders, but is prevalent in all classes of society in Burma and constitutes a serious problem. To reduce the evil, Government has promoted

the formation of co-operative societies and has, I believe, attempted legislation to prevent the alienation of land. The point I wish to emphasize, therefore, is that although it is the genera policy of Government to prevent indebtedness, the Forest Department under the system of prepaid licenses plays into the hands of the money-lenders.

At one time traders were allowed the option of taking out postpaid licenses, but it was the general opinion of Forest Officers that the disadvantages of this system outweighed those of the prepaid system, and the system was, therefore, abolished. I do not remember clearly what the objections to this system were, but believe that two objections were that the system involved large payments being made to measuring officers, which often led to fraud, and that frequently great difficulty was experienced in collecting the revenue due.

A description of a deposit system under which it is believed that the disadvantages of both these systems could be partly eliminated may, therefore, be of some interest. Whereas under *both the prepaid and postpaid systems money is remitted to the* treasury as revenue, it is suggested that money should be paid into the treasury as a deposit which would subsequently be transferred to revenue by a book entry when the timber has been assessed for royalty. Ordinarily a man would be called upon to deposit only a small amount before obtaining a license, and would be allowed to deposit the balance at his own convenience, provided that it was paid in before the timber was brought to the marking place for assessment of duty. On the other hand, if a man worked unsatisfactorily or gave trouble by failing to deposit sufficient money to cover the royalty on the timber extracted, he would be placed on a black list, and in future before obtaining a license would be required to deposit an amount equal to the whole revenue. In the former case, the man would practically be given all the advantages of the postpaid system and at most would only require a loan for a month or so, whereas the latter, on a *pyingado* license for 100 tons at Rs. 5 a ton, would have to raise a loan of Rs. 500, and if extraction took 12 months, would have to pay about Rs. 180

in interest. The system would, therefore, offer very strong inducements to traders to work properly and to be punctual with their payments.

The system is elastic and allows every possible variation between the prepaid and postpaid systems, so that a variety of cases could be dealt with in a simple manner. For instance, traders are often slack in working out their timber within the period of their license and the practice could be discouraged by insisting upon a further large deposit before granting a renewal of the license.

When a man takes out a license for, say, 100 tons of timber, he cannot be expected to work out exactly this amount. Supposing he works out 92·8 tons of timber, he is morally entitled to carry on the balance of 7·2 tons, and these small balances are often troublesome to adjust. Under the prepaid system a license is practically a receipt for revenue paid, but under the proposed system any balance would remain at the man's credit and could be utilized against the next consignment of timber extracted under another license.

Under the proposed system it would be quite feasible to prevent any money being paid in cash to measuring officers. Under a prepaid license it is customary to allow the measuring officer to collect the duty on a small excess of timber in cash. Under the postpaid system it is inevitable that measuring officers should sometimes accumulate in cash sums of money greatly in excess of the amount deposited by them as security. Under the proposed system, however, traders would have clearly to understand that before any timber is brought to be marked, sufficient money must be deposited to cover the duty, and if the amount deposited was short even by one or two rupees, it would not be unreasonable to refuse to pass the timber until a further deposit was made and in the meantime to charge depôt dues. Any slackness in this respect would render the man liable to be placed on the black list.

As regards accounts, when timber is measured, the licensee would be required to produce his license and deposit chalans. The latter could be endorsed with a special stamp 'transferred to revenue Rs. ' and any chalan on which there was any balance

could be returned to the licensee. The following example shows the kind of entry which would be made in the measuring officer's accounts:—On the debtor side, "23-3-17 to be received from Mg Po *Maung of Kindat duty on 92·8 tons of pyingado (license No. 9374,* dated 25-4-16), Rs. 464." On the credit side, "by deposit chalan for Rs. 50, No. 53, dated 25-4-16 on the Kindat treasury in full Rs. 50."

"By part chalan for Rs. 500, No. 19, dated 9-3-17, on the Paungbyin treasury Rs. 414."

The license and the first chalan would be attached to the accounts and be submitted to the office, but as there is a balance of Rs. 86 on the second chalan, it would be returned to the licensee.

I would suggest that each trader should be provided with a pass-book. On the credit side would be entered the amounts deposited, and on the debtor side the amounts transferred to revenue. If these books were carefully written up, they would obviate the necessity of maintaining a separate ledger account for each man. On applying for a license, a man would have to produce his pass-book, which would show the balance at his credit, the scale on which he has been working, whether he has been dilatory in his deposits, etc.

I would suggest that it would be unnecessary to show these deposits in the accounts submitted to the Accountant-General. It would, however, be desirable that treasury officers should submit with the consolidated treasury receipts a statement showing the amounts deposited on account of forest revenue each month. These amounts could be entered in a specal register in which sufficient space would be left to enter the cash account number and date when the amount is subsequently transferred to revenue. A form would have to be submitted monthly to the treasury showing in detail the amounts transferred to revenue. This would be compiled from the measuring officer's accounts. In the treasury officer's accounts the transaction would be adjusted by showing "refund of Rs.——as shown in D. F. O.'s form" and contrariwise "remitted to forest revenue" the same amount. A chalan for the

whole amount transferred to forest revenue during the month would have to be made out and entered in the schedule of remittances.

No entry would be made in form 35 until the timber had been assessed for duty. The revenue would be merely a summary of the measuring officer's accounts and in the cash-book this would be balanced by the chalan showing the amount transferred during the month from deposit to revenue. The preparation of form 10 would be greatly simplified. In most divisions when a license is issued it is usual to show, as extracted during that month, a corresponding amount of timber. In one or two divisions, however, timber is not shown as extracted until it is actually assessed for duty. This method is doubtless more accurate, but it makes the form extremely long and complicated. As the form is prepared in two entirely different methods, it is evident that the provincial totals are incorrect and that the form is a farce. Under the proposed system, the deposits would not be shown in the accounts and form 10 would, therefore, show only the amounts of timber actually assessed for duty during the month and corresponding revenue and would be absolutely correct.

Experience has apparently shown that all Government officials are fools and therefore Codes and Regulations, Manuals and Standing Orders are multiplied in order that we may have as little opportunity as possible for exercising our discretion and thus gradually our judgment becomes atrophied. In the same way the prepaid system of licenses is the outcome of experience, and is based on the assumption that all timber traders are blackguards. We do not trust them, and when we do business with them we insist on receiving our money in advance, and thus give them no chance of improving their moral characters. Under the proposed system they would be put to the test. It might be found that not a single trader could be trusted, and in that case all of them would be placed on the black list and be required to deposit all the royalty in advance before obtaining a license. We should, however, be no worse off than before and we should avoid payments being made to measuring officers in cash, we could insist on licenses being given up on expiry, instead of being extended so

that any small balance could be taken out, our returns would show more accurately what amounts are being extracted, etc. On the other hand, even if only one timber trader could be found to work satisfactorily, he would save enormously in interest to money-lenders and in fact would derive so great benefits that in time others might be induced to follow his example. Might not this system therefore ultimately bring about the moral regeneration of timber traders?

On the other hand, this system would involve some slight changes. Treasury officers, measuring officers, clerks and executive forest officers would have to prepare their accounts and returns in a manner to which they are not accustomed. As all these are Government officials and have, from the first day of their service, been trained not to use their common sense, would not any such change result in utter chaos and confusion?

Personally, I consider that the system described has many points in its favour, but whether it would be practicable to make any change or desirable to give up a system with which timber traders and subordinates alike are well acquainted, is a matter on which I refrain from expressing an opinion.

SOME IMPRESSIONS OF THE KULU FORESTS.

BY H. L. WRIGHT, I.F.S.

During last July I was able to spend ten days in Kulu, and, while touring the division with Mr. Trevor, had the opportunity of seeing the results of many of the experiments made by him regarding the regeneration of Deodar and also examples of other silvicultural works being carried out in the division. These notes make no attempt to describe in detail any of the work seen, but are merely impressions carried away of what has been attempted and what has been done.

Before being in the division more than a couple of days, there is one outstanding thing which no Forest Officer could fail to notice, that nearly every forest bears visible signs of the hand of the Forester. Practically all the Deodar and Kail forests have

been cleaned and thinned and are now beginning to show what properly tended forests should look like. This is far from being the case in many divisions in India, and coming from a Native State, where forest management is as yet in its infancy, I found it particularly noticeable. The atmosphere of keenness which prevails throughout the division is also very striking, everybody down to the latest joined Forest Guard shows an interest in his work and knows something about it, and does not think that forestry consists of sitting in villages and writing reports. The reason for this is that everybody has some definite work to do, by the results whereof he is judged. The outcome of this is a division manned by men who may truly be called 'foresters,' and who are not merely policemen and chaukidars. Several of the subordinate staff have been trained at the Punjab Forest School and the quality of their work is a splendid advertisement of the sound training which is given at the school.

The chief interest of the Kulu forests, however, lies in the regeneration of the Deodar under the Regular or Shelter Wood Compartment System. Mr. Trevor has already given the results of many of his experiments in a paper he read before the Punjab Forest Conference of 1915, which was afterwards reprinted in the *Indian Forester* for November 1915. Since this was published the revision of the Kulu Working Plan has been sanctioned, and the preliminary report, which has been accepted, lays down the general application of this system of management to all except those forests which are too precipitous to lend themselves to this treatment.

Having seen some of the results obtained under the 'Regular System' I think it amazing that it has taken so long for this system to be adopted. Of course it has not given successful regeneration in every case, but that is not so much the fault of the system, as the want of knowledge in applying it. For it must be remembered that the work done so far has been largely experimental and as much has been learnt from the failures as from the successes. Moreover, there is still much to learn and Mr. Trevor would be the last to profess to be able to get natural regeneration wherever he wants it. He justly claims, however,

that it is obtained in the majority of cases and that the percentage of success obtained under this system is considerably higher than it was under the old 'Selection System.' Even in Europe where the silvicultural knowledge is fairly complete, most Forest Officers expect to have to stock artificially at least 10 per cent. of the regeneration area, and here in India, with our imperfect knowledge, we can hardly hope for better results.

In many places the experiments have been made under the worst possible conditions. The forests of Kulu are heavily burdened with rights, and near villages, not only are they heavily grazed, but the people scrape the ground absolutely bare of needles and humus. It is hardly surprising then, that under these conditions, the 'Selection System' has given, in many places, little but a crop of weeds. Several such areas have now been taken in hand, closed, fenced, and where the canopy was not already sufficiently open, a seeding felling made, and the result has been a mass of young growth. The difference between the fenced and the unfenced portions of the same forest, where all other conditions are equal, is most striking—on one side of the fence practically complete regeneration, on the other nothing but bare soil and weeds.

The Regular System appears particularly suitable to the conditions of Kulu. Under the Forest Settlement only about one-third of the total area of forest can be closed to rights at a time, and it is therefore impossible to have regeneration fellings going on over the whole division, that is, if you want to close areas under regeneration to grazing, and without such closing scientific forestry is impossible. Of course there are many places in which most excellent regeneration has been obtained in open forest, and Forest Settlement Officers have often used this as an argument to show that closure to grazing is not essential for reproduction. But it must be admitted that regeneration under these conditions takes considerably longer to establish itself, and also that in some places no reproduction is, or ever will be, obtained under these conditions, and if we are to manage our forests as profitably as possible, it is essential that we get our reproduction on the ground without delay. Indeed, every year which passes

after the seeding felling makes matters more difficult. Another, and to my mind, the most important advantage of the Regular System is that the areas under regeneration are definite and the Divisional Officer and his staff can give them their constant attention, and not leave the young crop to look after itself as was done under the Selection System. From what little I was able to see of this system in working, I obtained the impression that there is but one key to success and that is work, continuous work from the time of the first seeding felling until the new crop is fully established.

One of the most interesting results obtained from the experiments made in Kulu is the beneficial effect of burning débris and refuse in the regeneration area. I was able to see only one area so treated, Riampur forests, where after the crop was opened up in 1914, the refuse was collected in heaps and burnt, and the ashes having been thoroughly mixed in with the soil, the burnt patches were sown broadcast in December of that year. All these burnt patches are now covered with a dense growth of fine healthy young Deodar, one to one-and-a-half feet high. When Mr. Trevor introduced this subject to the Punjab Forest Conference of 1914, and produced a year old seedling no less than ten inches high, his remarks were received with incredulity, though as a matter of fact he had chosen no exceptionally robust specimen. The adverse effect of an excessive deposit of coniferous needles was commented on at the last Punjab Forest Conference. Further observations leave little doubt that this factor is one of supreme importance, and it is believed that this excessive deposit is largely responsible for the absence of reproduction in the Spruce and Silver Fir forests. This theory is now receiving attention, but some years must pass before any definite pronouncement can be made.

Silviculture in Kulu makes no attempt to grow Deodar in places where it has not grown naturally before, nor to replace mixed crops with a pure crop of Deodar. The object of the new plan is to grow each species of tree in the locality most suitable for it; where mixed crops are already in existence, the proportion of Deodar will be increased if the locality is suitable, but the

mixed character of the crop will be maintained. Foresters are often apt to try and extend their more valuable species at the expense of everything else, without always considering the factors of the locality. An example of this is found in Kulu, in the Monali plantations of Mr. Duff. These forests are a magnificent example of what can be obtained by planting, but the locality, being on the banks of the Beas, is moist and damp and not really suitable for Deodar, and it is probably for this reason that the crop is now suffering from an attack of *Peridermium Cedri*. Forestry in Kulu also aims at making every acre of land under working carry a profitable crop. Blank places, suitable for conifers, are being stocked artificially; where conifers cannot be grown, walnut and ash are gradually being substituted for the rubbish cumbering the ground. It may be argued that it is little use going to the expense of planting species for which there is no market, but this shows a want of imagination. Imagination is a particularly useful quality in a Forest Officer, and many of us are apt to forget that we are working not for the present but for perhaps a hundred years hence. True, walnut and ash have no market value at present, partly because they do not exist in sufficient quantities, but both are most valuable timbers and it is hard to believe that the next 50 years will not see Kulu linked with the outside world, if not with a light railway, at least with a motor road, and it is surely a sound policy to get a stock of these species in hand for the time when they will become marketable.

Those who have followed Mr. Trevor's experiments in Kulu must admit that he has been able to add a great deal to our silvicultural knowledge of the Deodar, leading to a revolution in the forest management in these hills. In concluding these notes on a most enjoyable tour, I should like to enter a plea to other Divisional Officers to make similar experiments in their own divisions. Our knowledge of many of the Indian trees is far from complete; in the hills, for instance, we know little or nothing about the Spruce and Silver Fir, and here is a wide field for research. Small areas of 10 to 20 acres are quite sufficient to experiment on, if they are carefully observed and the results recorded. Even

if the experiments are a failure, there is little harm done, and in most cases a negative result is far better than none at all. By study, an exact silvicultural knowledge can be obtained of all our trees, leading to the scientific forestry of the future, where every acre will be producing a full crop. Commencing in this way, the time will come when forestry in these hills will rival that of the continent of Europe; as every compartment comes under regeneration, it will be converted into an improved crop until in the second rotation Government will possess a property of incomparable value producing a revenue unthought of previously.

NOTE ON *URGINEA INDICA*, KANTH (VERNACULAR "KORIKAN" OR "KANDRI") FOUND IN BUNDELKHAND AND ADJOINING CENTRAL INDIA STATES.

BY G. O. COOMBS, EXTRA-DEPUTY CONSERVATOR OF FORESTS.

The following note is written to place on record the results of enquiries and investigations made up to date about the "Korikan" plant, the bulbs of which have been found to be a valuable product for "size" and a substitute for "squills." The natives of Bundelkhand have long been aware of its excellent properties as a sizing material and the local weavers use it almost exclusively, whenever procurable, for sizing the cloths they weave in the villages; to this end there is a certain amount of local trade in the bulbs, which are exported from parts of the hilly country, where the plant is more plentiful, to the weaving centres in the plains or black cotton soil tracts, where it does not occur to any extent. The plant is a lily with onion-like bulbs, and flowers about Easter time. The flowering shoots, which appear before any leaves come out, were noticed last year early in April, pushing their way out of the hard ground all over the hill-sides. The flowering heads, when pushing out of the ground, are protected by a sheath over each bud on the outside, attached by the middle to the point where the flower bud stalk and main flower stalk meet. These bracts fall off early in the

development of the inflorescence and leave a scar. Only the lower bracts are fully developed, the upper ones having their lower halves abortive.

The flowering shoots are pinkish brown in colour, and are the only part of the plant above ground for some time, as the leaves do not appear till some time in June when the flowering is over. During the first week of April, the flowering shoots were to be seen in all stages of growth, some just pushing out of the ground, others as much as 36 inches long, with flower buds about to open. Owing to their drab colour or want of colour the shoots are very inconspicuous and insignificant looking and do not attract much attention.

It is usual to see two flowering shoots coming out of a single bulb, but where a cluster of bulbs occurs each bulb has one flowering shoot. The inflorescence is a straggling raceme, the flowers being arranged singly on short pedicels, varying from $\frac{1}{2}''$ to $1\frac{1}{2}''$ long, coming out alternately from the main stalk, the buds being $\frac{3}{16}$ to $\frac{1}{4}$ inches long and obovoid when not open. The flower consists of the following parts :—

6 perianth segments, purplish brown, 3 inner and 3 outer.

6 anthers, two-lobed, rather large, greenish yellow.

3 pistils forming one short-necked ovary with 6 sutures situated above the perianth.

The flowering and seeding period extends over about two to three weeks and by the end of April the seeds are dispersed. By the end of June there is little or no trace of the flowering stalks which dry up and get knocked down by cattle, etc., by which time, however, the leaves of the plant have appeared, and one can see how common it is all over the ground, growing equally well under tree cover, in the open parts of the forest or in village waste lands.

The seeds are black, very flat and light and being winged also are easily scattered by wind. Some seeds were sown by me this year in pots and in the ground during July. They took about a week to germinate and came up freely, but the seed covering being tough they required a good deal of wetting before they began

to sprout. The seedlings have grown rather slowly ; they now have about 3 or 4 needle-like leaves and have developed a tiny bulb.

The plant appears to be widely distributed and occurs in quantities in the hilly and undulating country along and on the Vindhyan high land. The tracts in which most of the "Korikan" is found in the Jhansi Forest Division are the Manikpur hills and plateaux situated in the Karwi sub-division of the Banda District and in the South Lalitpur hills and 'Pathar' in the Jhansi District. It is also reported to occur in the adjoining Central India Native States. The quantities available in the Manikpur tracts, about 100 square miles in extent, are very large and almost inexhaustible: here the plant occurs in great profusion and within reasonable distance of the railway. As this tract is tapped by the G. I. P. and E. I. Railways, export of the bulbs can readily and economically be carried out. Small quantities have in past years been exported by local traders from Bahelpurwa and Manikpur railway stations to Mau-Ranipur and other places, but the trade is capable of further extension.

The cost of the bulbs f. o. r. at Manikpur, Markundi and Bahelpurwa railway stations would be from 5 annas to 12 annas per maund according to distance.

The way in which the Kories or local weavers make use of the bulbs is as follows :—

A quantity of the bulbs is boiled with water, after which they are washed in cold water and then reduced to a mash by grating them against a rough tin grater. The pulp is then strained with as much water as is required for the work in hand, making a sticky liquid with which they size the cloth.

The *size* is said to have an irritating effect on the skin on which account it is not used by Dhobis. It is believed that the bulbs are best gathered after the monsoon, when they are supposed to contain most sizing material, but in practice they are gathered during the rains when the ground is soft and the leaves show where the plants are to be found, and also during the summer, in fact, whenever labour is available. The local weavers consider the "Korikan" their best sizing material if they can get it up to 6 pies

per seer, *i.e.*, Re. 1-4 per maund. In some places and at certain times they may pay up to 9 pies per seer. If it is more expensive they use other things such as barley, 'juar,' 'kodon,' and more rarely rice which is more expensive.

I first noticed the plant in the Manikpur forest in June, 1913, and on making enquiries regarding its local uses came to know that native weavers made use of it. Seeing the abundance in which the bulbs occurred in the forests and the profit that might result from a large export trade in the product being established, besides the indirect advantage of a loosening of the soil and provision of a good seed-bed for forest plants which would result from the digging out of the bulbs on a large scale, I set about making enquiries with a view to extending its export and getting the large Cotton Mills to take up the use of the bulbs in their works if possible.

The Forest Economist at Dehra Dun was also addressed on the subject.

The Cawnpore Cotton Mills and the Elgin Mills Co., Cawnpore, wrote to say that they did not use the bulbs but asked for samples for testing, which were duly sent. The Elgin Mills completed the tests and wrote saying that their tests showed that a valuable sizing compound can be extracted from the bulbs; but the firm was of opinion that to do this commercially it would be necessary to have a proper refining plant and that it would hardly pay any individual firm to instal the necessary plant. They were of opinion, however, that the bulbs could be used by makers of vegetable sizes and suggested enquiries being made from certain firms dealing in sizing materials and from the Director of Industries, Cawnpore. They also mentioned that should anything come of the enquiries, and if any firm should take up the manufacture of "Korikan" size they would be pleased to hear further about it.

The Cotton Mills wrote to say they had not the machinery for extracting the size.

The Director of Industries, Cawnpore, was addressed on the subject, and he has very kindly made tests and experiments which give promise of good results. Further tests on a commercial scale are now being made and their result is awaited.

The Director of Industries writes to say that there is no starch in the bulbs, but that so far as his investigations have gone, they provide a valuable sizing agent, and he has hopes that the size may be taken up by the Cotton Mills. He further states that the bulbs furnish a substitute for gum tragacanth, and as such should have a commercial value, and he has reason to believe that they may have medicinal value as squills. He is making enquiries regarding all these openings.

The Sizing Materials Co., Bombay, who were supplied with a sample lot of bulbs for experiment, sent them to England, but they have not yet had a report from their Home firm—the matter having been delayed, owing to the war, but not forgotten.

The enquiries made from the Forest Economist at Dehra Dun have resulted in the plant being identified by the Forest Botanist as *Urginea indica* and samples being sent to Messrs. Bathgate and Co., Calcutta, who report that they do not know of any market for the *Urginea indica* in quantity but that a certain quantity might be disposed of to the Government Medical Stores for use as a substitute for *Urginea Scillæ* which is the imported drug. As a source of mucilage, for use in the textile industry, they think there is not much scope in Bengal, as it is not a cotton manufacturing province and jute requires different treatment. I am informed by the Forest Economist that Watt's Commercial Products of India, page 1048, mentions that "Korikan" is closely allied to *Urginea Scillæ* which yields the true "squills" of commerce and that, in fact, it is used and sold by native druggists as a substitute for "squills" which are imported into India from the Mediterranean.

Although the enquiries and experiments are not yet complete the results have so far been interesting and give promise of this product being more largely utilized in the future. A new industry may possibly be developed for the local manufacture of sizing material, if the cost of manufacture and selling rates work out satisfactorily.

I gratefully acknowledge the help and courtesy received from the various officers and firms connected with the enquiries about

the " Korikan." I am much indebted to the Forest Botanist for the identification of the plant and the Forest Economist for his help in the matter. Also the Director of Industries for taking up the matter, and making practical tests which will doubtless prove of great value in placing the product in the market on a commercial scale.

FORESTRY IN MESOPOTAMIA.

BY M. R. K JERRAM, I.F.S.

What the political settlement in Mesopotamia will be after the war no one can say at present, but the ordinary person with no inside knowledge assumes that we shall, if successful, take over the country up to Bagdad. The enormous potential value of the country is universally recognized, and one may take it that those in high places already have their plans laid for its development. Irrigation works and railways will of course occupy the foremost place in these plans, but it is of the utmost importance that the question of wood-supply should receive adequate consideration. This is a matter which one knows is very liable to be overlooked and it would be well if the Indian Forest Service were to start taking the same interest in it as Indian Irrigation Engineers are doubtless taking in the question of irrigation. India is the home of forestry in the British Empire, as it is of irrigation, and it is obvious that Indian Forest Officers must take as prominent a part in the development of the former in Mesopotamia as Indian Irrigation Officers will in the latter.

As regards the present supply of wood, from the little I have seen and heard there are practically no trees in Mesopotamia other than date-palms. The dryness of the climate does not seem altogether sufficient to account for this, as one would expect to find some trees, at least along the rivers and water channels. One explanation, which I have heard and the truth of which I cannot vouch for, is that the Turks tax all trees and that therefore the inhabitants cannot afford to allow any trees other than date-palms to grow. A little fuel can be obtained by much labour in many places by digging up the roots of bushes (an *Acacia*, *Zizyphus*,

Tamarisk and a few others). Far to the north and north-west lie the Kurdistan hills. What forests these contain I have no idea but probably there are books of reference in India which contain some information on the subject. I believe, however, that fuel and timber for building the boats on the Tigris are floated down from these hills in the Tigris and its tributaries. To the west, within 40 miles of the Tigris at their nearest point, lie the Persian hills, a portion of which is marked on the map as scantily wooded limestone hills. Whatever may be the supply of wood in distant hill areas, Indian experience indicates that the plains of Mesopotamia, except in the immediate neighbourhood of the rivers, must remain dependent on wood produced locally for domestic and agricultural purposes. Whilst the planting up of the river banks and areas subject to perennial floods (if any such areas remain when the irrigation schemes have been completed) should receive attention, the most important source of wood-supply must, owing to the dryness of the climate, be irrigated plantations similar to those in the canal colonies of the Punjab. It seems highly probable that, in addition to supplying agricultural and domestic needs from these plantations, it will prove economically sound to utilize them for growing timber for railway sleepers and constructional works, since, in so far as I am aware, this country has the great advantage over India that there are no white-ants to limit the species of timbers suitable for these purposes.

The following appear to be the more important points requiring consideration in deciding on a forest policy for Mesopotamia :—

(1) The existing condition of the forests in the Kurdistan hills where the Euphrates and the Tigris and their tributaries rise, to what extent these forests affect the water-supply in these rivers and whether we can take any steps, if necessary, to insure their continued existence. Presumably these hills will be outside our sphere of influence in any eventuality.

(2) How much timber is likely to be obtained by river or rail from north of Bagdad, what will be its cost, for

what purposes will it be suitable, and is the supply likely to be continuous.

(3) Similar points to those in (2) as regards the Persian hills on the western frontier. The nearer portion of these hills may come within our sphere of influence. It appears from the map that the rivers which rise in these hills dry up before reaching the Tigris.

(4) What areas in Mesopotamia are suitable for planting without canal irrigation.

(5) What areas should be set aside for irrigated plantations with a view to providing for the future:

 (*a*) Domestic and agricultural requirements of the local population.

 (*b*) Requirements of railway sleepers.

 (*c*) Requirements of large towns.

The question of species to be planted will of course require careful consideration. In this connection it may be remarked that the climate is similar to that of the northern Punjab, except that there is no monsoon and that there is a considerable rainfall from January to March. The soil is alluvial, but the existence of brackish water in many places may indicate the presence of salts injurious to certain species. The climate, considered from a personal point of view, is not at all a bad one. Too much importance must not be attached to stories of the hardships undergone by the troops on active service. A hot weather campaign in the Punjab, carried out under similar conditions, would be even less bearable. In other words, when bungalows have been built and the normal conditions of life in India are established in Mesopotamia, the latter will be a more comfortable country to live in than most parts of the former. The hot weather is short, lasting from about June 1st to September 15th. During this period the day temperatures are very high. We had it up to 124° in our E. P. mess tent and for days together it would touch 118°; but the maximum shade temperature normally registered would be some degrees lower than this. What saves the situation however is the nights, which are really cool and often after a hot day feel even

cold. The fall in the temperature at night is so great that well-built bungalows kept shut up during the day-time would probably never get very hot.

The climate at Basra and Kurna is somewhat less pleasant, being damp with rather hot nights during the hot weather; but when the inundations are drained the climate will probably become the same as that further up the Tigris. As regards sport, there is good fishing and small game shooting. The sand-grouse are seen in flocks of thousands and provide every kind of shot. A poor shot can always get a bag of sorts and a good shot will find that he needs all his skill to shoot them when they are flying down wind over a trench or dry water channel in which he is waiting. They have a pleasant habit of keeping on the move and continually coming back to the same ground. I believe there is excellent duck shooting on the inundations in the cold weather. If we take over the country, permanent cantonments are bound to be established, and those on the Tigris, particularly, should be very pleasant places to live in, similar to stations in Northern India, the Pusht-i-koh hills which go up to 9,000 feet taking the place of the outer Himalayan Range for hill stations.

A NEW SPECIES OF ACACIA.

BY H. H. HAINES, I.F.S., F.L.S.

Acacia Donaldi, *Haines*; ab A. pennata, *Willd.*, petiolis communibus brevibus, foliolis majoribus, leguminis colore subflavo, fructus maturescentis tempore distinguitur. A. Donaldi saepissime quidem erecta est, A. pennata autem scandens semper est.

(List of Trees, Shrubs and Economic Herbs of the Southern Circle, C. P., p. 100; = A. pennata, *Indian Forester*, December 1904, p. 573.)

Arbuscula 15—25 ped alta vel rarissime frutex grandis scandens, cortice pallido. Rami sub-teretes, saepe lineis atris in longitudinem aculeis minutis instructis vel aculeis absentibus. Ramuli pubescentes vel demum glabrati. Ramuli, petioli, rhachi, inflorescentiaeque ramuli, aculeis reflexis parvulis vel in ramulis

4 mm. attingentibus instructi vel interdum inarmati. Folia saepe fasciculata rigide patentia parce ciliolata. Rhachis communis 8—18 cm. (rariore 26 cm.) longa, parte infra pinnis (petiolo incluso) 10—15 mm. longa, pubescens, prope basin glandula oblonga saepe depressa vel aborta inter juga superiora 1—7 glandulis sessilibus instructa. Pinnae plerumque 16—20-jugae (in foliis brevibus 10-jugae in foliis robustis usque 27-jugae), eae in medio rhacheos 4--9 cm. longae, rhachi praesertim superne pubescente. Foliola in pinnis mediis 25—40-jugae, rariore 50-jugae, 5—12 mm. raro tantum 2·5 mm. (juxta inflorescentiam) longa, ·8—1·2 mm. lata, mucronata, basi obtuse semi-sagittata vel semi-hastata, costa obliqua, nervuli plures, pagina subtus pilis microscopicis pallida. Stipulae 3—4 mm. lineare-subulatae cito caducae. Capitula in paniculas terminales disposita, albida vel pallido-lutea, 1·25 cm. diametro, pedunculis 1·5—2 cm. longis plerumque 3 in bracteae cuique axillo (bracteae folia juvenilia sunt hinc pedunculi demum axillares fiunt). Calyx 3·5 mm. longus fere glabrus 5-nervosus, lobis acutis. Corolla 4·5—5 mm. longa glabra, lobis lanceolatis apicibus inflexis acute mucronatis. Ovarium sericeum stipite 2 mm. longo suffultum. Legumen 8—18 cm. longum 2—2·5 cm. latum subflavum vel luteum vel demum fuscum nunquam purpureum (ut in A. pennata), in juventute subturgidum, usque ad 5 mm. crassum, ad basin cuneatum in stipitem brevem sensim attenuatum.

Central Provinces of India and extending into Bengal. Jabalpur, *Hole*; Chanda, Drug, Raipur, Bilaspur and Sambalpur districts chiefly on sandstone and quartzite plateaux, *Haines*; Saugor, *Witt*, 98.

Fls. August. Fr. ripens Nov.-Dec. when those of A. pennata are still purple and their seeds but slightly developed.

Vernacular names :—Ramna (Jabalpur, fide Hole); Chil (Chanda, etc., C.P.); Ailah (Saugor, fide Witt). Mr. Hole states that the leaves have an acid taste.

Apparently Mr. Hole, when in the Central Provinces, was the first to note the distinctness of this species. He sent specimens to Calcutta, where it was identified as Acacia pennata, and shortly afterwards to Sir Dietrich Brandis. Sir D. Brandis quoting the

vernacular name 'Ramna' wrote in reply " = Acacia pennata" and that he regarded this pale-pod form as the true type of A. pennata. Mr. Hole also published a note on the plant under its vernacular name in the *Indian Forester* (loc. cit.) and pointed out the field characters distinguishing it from A. caesia.

The tree was named by me after the late Mr. James Donald, formerly Deputy Conservator of Forests in Chanda, who had also recognized its distinctness and wrote a list of Chanda trees. I cannot refrain here from an expression of keen regret at the recent sad death of this promising officer while serving in the Indian Army Reserve.

As regards what is the true type of Acacia pennata I think it is very doubtful whether Acacia pennata, *Willd.*, is the same as the Mimosa pennata of Linnaeus, or what is the true type, but it is certainly not this plant. There is no specimen *so named by Linné* in the Linnaean herbarium,* but from the Species Plantarum and the Flora Zeylanica the type would appear to be a Ceylon plant collected by Paul Hermann between 1670 and 1677 and much more resembling a form of what is now called A. Intsia.

FLOWERING OF *DENDROCALAMUS SIKKIMENSIS.*

The Divisional Forest Officer, Kalimpong Division, Bengal, informs us that *Dendrocalamus sikkimensis*, Gamble (the Bhaloo Bamboo) has flowered in his Division at an altitude of 3,000—4,000 feet.

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* There is a plant named *Mimosa pennata* in the herbarium but *not* by Linnaeus, and it does not even belong to this section of Acacia.

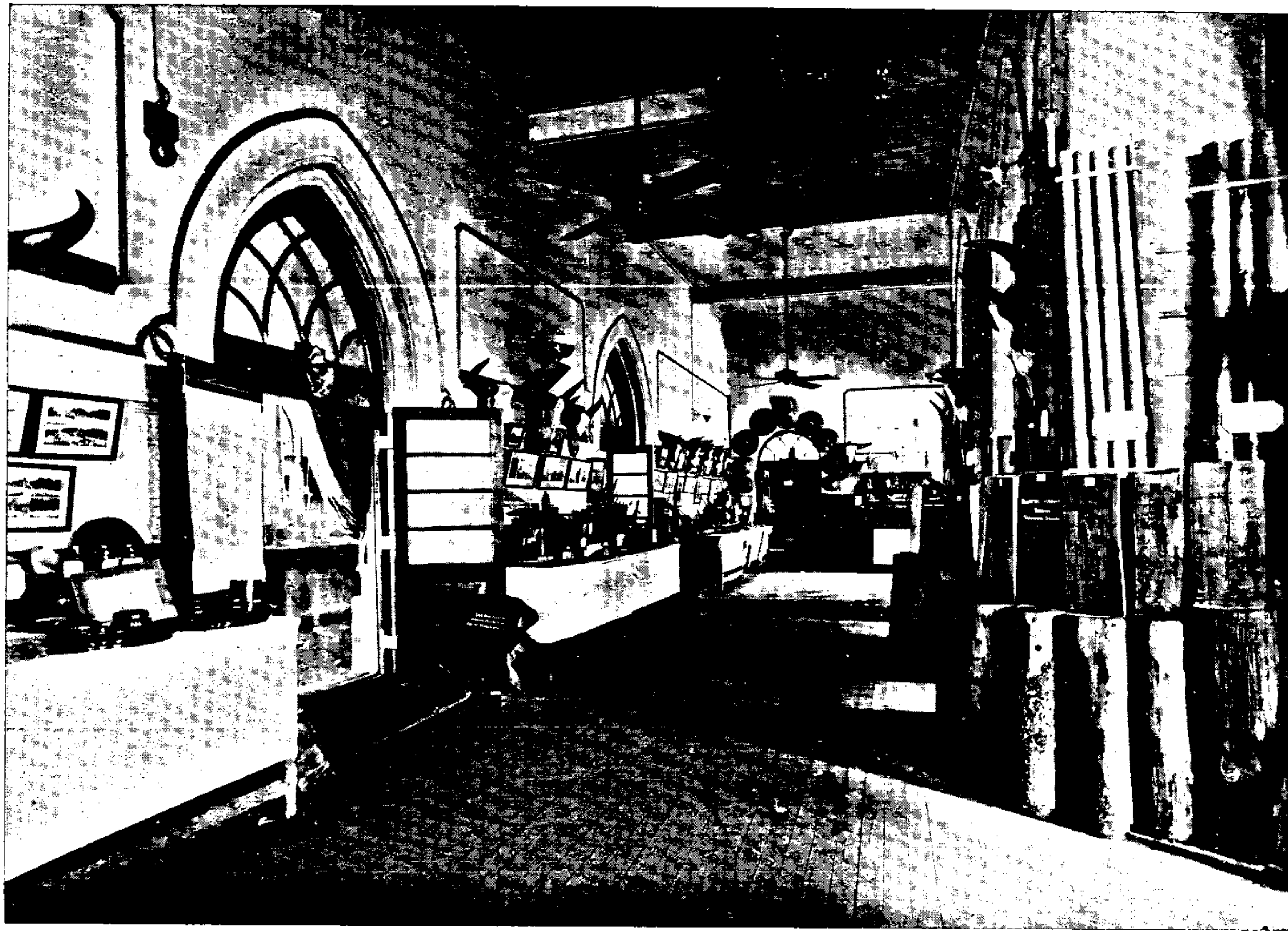

Photo.-Mechl. Dept. Thomason College, Roorkee.

The Burma Industrial Exhibition, Forestry Section.

EXTRACTS.

THE BURMA INDUSTRIAL EXHIBITION.

SOME OF THE FEATURES.

The Forestry Section.

The Arts and Industries Exhibition which was opened by the Viceroy on Monday is the most ambitious effort yet made in Burma to bring before the general public an idea of the resources of the province. In addition to the established industries such as oil, timber and rice, there are many others. The forestry display is the largest of any one section, and is a very complete one; while adjoining it is a fine exhibition by the Bombay-Burma Trading Corporation, Limited, of what can be done with teak.

The Forest Department display has been prepared by Mr. A. Rodger, Forest Research Officer, and as to its scope he had the valuable assistance of Mr. Rogers, Chief Conservator of Forests, Burma. There are specimens of more than 190 Burma woods exhibited. A number are very hard woods, which would make fine substitutes for teak. These specimen woods are well arranged. But these are not the only things to be found in the forestry section. There are samples of the principal bamboos of Burma, as well as a collection of objects in general use by the villagers and hill tribes, made of the various woods found in the Burma forests. Among the bamboos on exhibition are samples of the kind from which good paper-pulp and paper can be made, and some of the paper is to be seen in this section. Paper made from 'kaing' grass and the grass itself form part of the exhibit, while there is a very interesting collection of fibres, oleo-resins, gums and other minor products. One of the largest single displays is that of the Burma Match Company, which shows match-making wood in all stages up to the finished match in boxes. The Irrawaddy Match Company of Mandalay have a smaller but not less interesting exhibit. There are samples of various forest seeds and seedlings of forest trees. An interesting portion of the forest section is the display of timbers

damaged by insects and the insects which have caused the damage. Close to this are pieces of timber treated with antiseptics, showing the preservative effect. There are framed botanical specimens, and the photographs of trees and forest scenes give an excellent idea of forest growth and life. On the walls in glass cases, laid in cotton wool, is Mr. J. M. D. Mackenzie's collection of eggs of birds of Burma, which is attracting a great deal of attention, especially among the Burmese visitors ; also on the walls are sporting trophies from the forests of Burma. The timber specimens are shown in sections, large planks, half-cut logs, small pieces, etc., many of which are polished. The pulp exhibit is from Dehra Dun. The damaged teak shows bee-hole bores and the 'pyinkado' the damage caused by the larva of the beetle. Nothing that pertains to the Forestry Department is absent from this section. The section is located upstairs in the south-eastern end of the Jubilee Hall.

In the north-eastern corner is the exhibit of the Bombay-Burma Trading Corporation, Limited, where everything made in the Corporation mills and specimens of forest work can be seen. Splendid teak panelling and a very fine parquette block flooring attract attention at once, while a superb pair of elephant tusks weighing 150 pounds, which are mounted on silver on an ebony stand and from the tips of which hangs a gong, are the cynosure of all eyes. These tusks were taken from an old elephant which died in the jungle, being a fine worker up to within a short time of his death. Of the timber specimens there are scantlings, railway blocks, railway carriage wheels, mouldings, cabin casings, railway keys, planks, parquetting blocks, shingles, roofing material, etc. There are also models of a buffalo dragging a log, two buffaloes dragging a four-wheeled cart, two buffaloes dragging a *gindaik* (jungle cart), and also of them dragging a two-wheeled country cart. There are models of two elephants drawing a log and of them drawing a two-wheeled cart. There are also models of hand-sawyers. There is a beautiful card table of teak lent by Mr. Peter Marshall of Moulmein, and another solid piece of teak has been made into a table which has been beautifully carved by Mr. J. Whitfield Hirst; this is 45 inches wide in the middle. Everything that can be

made out of teak is shown here, and the collection of photographs, of which there are not less than forty, show scenes of forest work and at collecting stations as well as at the wolfram mines of the Corporation at Tavoy. There is a good-sized collection of specimens of wolfram from these two mines. The smaller models of elephants and buffaloes were carved by Maung Po Nyun, a clerk in the Dunneedaw mill, while the larger models were done by Maung Hla Pe, of Vegyaw. The teak panellings were made by a Chinese carpenter, Ah Kwe. The exhibit is one which has attracted large numbers of visitors since the opening and is with the forestry exhibit one of the features of this year's exhibition.

His Excellency paid a private visit to the exhibition before the public opening and inspected each section in detail.—[*The Rangoon Gazette.*]

GETTING RID OF TREE STUMPS.

A member of the Society wishes to get rid of the roots of yew trees, which are a source of danger to cattle. The cost of grubbing out the stumps is very high, and information is desired as to whether there is any sure method of killing the roots by inserting any chemical in a hole bored in the stump.

The Editor will be glad to print an account of the experience of readers who have successfully solved such a problem. Meanwhile, he may say that boring one or more holes in the stump and filling them with a saturated solution of saltpetre is said to be an effective method of riddance. The stump absorbs the saltpetre, and when the weather is dry it is said to be an easy matter to burn the stumps which are thus saturated.

An account may be given of a method which the Editor successfully applied two years ago in killing about a dozen poplars some 20 ft. high, and having a stem diameter at the base of 6 or 8 inches. The design was to kill the trees as they stood and to utilize the dead stems still standing in their original position for the training of creepers over them. In the early part of the summer a hole, slanting somewhat downwards, was bored with an

inch auger near the ground, the hole reaching nearly through the stem. Oil of vitriol, that is, crude sulphuric acid, was then poured into the holes by means of a pipette. In a few days the acid had been absorbed, and the holes were again replenished. In a short time the trees died, and so effectively were the roots killed that there has been no production whatsoever of sprouts.—[*Quarterly Journal of Forestry.*]

[From enquiries made recently in England we are inclined to doubt the practicability of the saltpetre method of burning out roots.—HON. ED.]

EFFECTS OF GRASS, AND CERTAIN OTHER PLANTS, ON THE GROWTH OF YOUNG ASH TREES.

BY PROFESSOR SOMERVILLE.

It has long been known that forest and fruit trees suffer in growth through grass and other plants occupying the surface of the ground; in other words, better growth is got when young trees are grown on ground that is ploughed, hoed or otherwise cultivated so that weeds are kept down. Even old trees suffer through the presence of grass and other plants, as, for instance, when a close, middle-aged or mature wood is heavily thinned so that light is admitted to the surface of the ground, which consequently "grasses over." While the roots of old trees often go into the soil to great depths, most of the actual feeding is done by rootlets quite near the surface. If in a close beech wood the humus is scraped away it will be found that at a depth of one or two inches the soil is full of root fibres; or if a load of soil is laid down near an old tree the mass of soil will in a year or two be found to be full of young tree roots, which have grown up into it. Even old trees, therefore, are much influenced by surface conditions, although, in this respect, they may not be so susceptible as young trees.

All trees are not alike sensitive to the restrictive influences of grass. Speaking generally, conifers are less affected than hardwoods, but even amongst conifers such genera as *Cupressus*, *Taxodium*, *Sequoia*, and *Thuja*, are much more affected than *Pinus*. Then, again, soil and climate appear to have a certain counteractive

influence, fruit trees making a much better fight against grass on deep, loamy soil in the West of England than on the gravel and chalk of Kent or Surrey.

The subject has been dealt with most systematically and exhaustively at the Duke of Bedford's experimental fruit warm at Woburn, and a large part of the 13th Report (1911) is taken up with a statement and discussion of the results obtained during the preceding sixteen years. The main conclusions may be thus summarized :—

1. The effect of grass on fruit trees is often so deleterious that all *growth is prevented, and the trees are frequently killed outright.*

2. Recovery of health by the trees has only occurred in cases where the roots could extend beyond the grassed area.

3. If ground hitherto tilled is allowed gradually to grass over the effects on the trees are less prejudicial than if grass seed is *deliberately sowed.*

4. Trees that had grown four years on grass-free ground suffered at once when grass was sown or allowed to establish itself and a similar though slower result was obtained with trees that had been growing on tilled soil for 12 years.

5. Certain varieties of apples, being more vigorous, suffer less than others.

6. The stock, whether paradise or "free," has but little influence.

7. Pears, plums, and cherries were affected nearly to the same extent as apples, but, in the case of these trees, standards suffered less than dwarfs.

8. If a tree is growing too vigorously, grassing up to within 5 or 6 feet of the stem was found to check growth and encourage fruiting.

9. Grassing tends to produce fruit of a high colour.

10. Where a circle, say 3 or 4 ft. in diameter, is kept free from grass round the base of a young tree, the tree is benefited, but *directly* even a *few of the roots extend into the adjoining* grassed area the pernicious effect on the growth of the tree is observable.

11. Forest trees were affected in the same way as fruit trees when grass was sown immediately after planting, but on light soil conifers were affected much less than fruit trees, and some recovery occurred as time went on, whereas in the case of fruit trees, the effect was intensified by time.

12. Eighteen different species of grass were tried and all were found to restrict growth, though the stronger grasses were more prejudicial than the less vigorous species.

13. Clovers also restricted growth, but the yellow colour of the foliage of the fruit trees, which is so characteristic when grass is used, was absent under the influence of clover.

14. The injurious effect of grass was proved not to be due to (*a*) interference with the circulation of atmospheric air in the soil, (*b*) the amount of carbonic acid gas in the soil, (*c*) soil temperature, (*d*) food supply, (*e*) physical condition of the soil, or (*f*) the micro-flora of the soil.

15. The deleterious effect of grass was found to be due to a substance produced by the grass roots, which acts as a poison to the roots of fruit and most other trees. The evidence on which this conclusion is based seems quite decisive, but it is too long to be reproduced here. The toxic substance is easily destroyed by contact with air, and this accounts for the fact that while fruit trees may make little growth if planted in an old pasture, the turf of that same pasture will greatly stimulate growth if it is made into a heap and occasionally turned over to promote decomposition.

The influence of grass and certain weeds on the growth of ash and larch was the subject of experiments by Messrs. Armstrong and Pratt, the results being reported on in this Journal last year (page 225). The trees were planted and the ground covered with the grass or other plants in 1912, and the results, as shown in 1913 and 1914, were as follows :—

1. The effects were distinct so early as the close of the first season.

2. The terminal bud often failed to mature, and the foliage was stunted and prematurely shed.

Effects of Grass, and certain other Plants, on the Growth of Young Ash Trees.

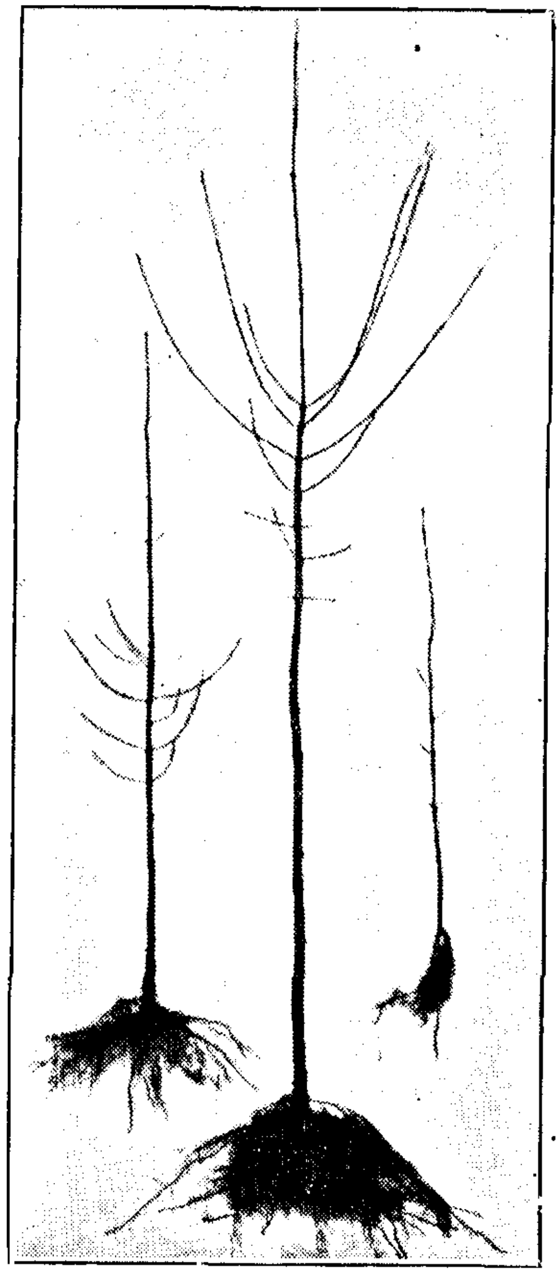

Photo.-Mechl. Dept., Thomason College, Roorkee.

FIG. 1.—TREE IN CENTRE GROWN ON BARE GROUND; TREES ON EITHER SIDE GROWN IN GRASS.

3. The annual shoots were much shorter than those produced by trees on plots where the surface of the ground was kept bare. Growth was only about half as much as the normal where stinging nettle and creeping buttercup, respectively, were used to cover the ground; whereas when grass was used it was as little as one-third, one-fourth or even one-eighth.

4. Considerable differences in effect were produced by the various species of grass; perennial rye-grass, couch, and fiorin proving most pernicious.

In an article that I contributed to Vol. III (1909) of this Journal, entitled "Planting on the Weald," I emphasized the importance of horse-hoeing and hand-hoeing young woods for the first two or three years, where this is possible, and I gave details with regard to the growth of a considerable number of species. The tree that resisted grass best was the Corsican pine, in fact this species seems to be little benefited by keeping the grass down.

The following notes relate to two experiments carried out on ground attached to the School of Rural Economy in Oxford :—

In the month of March 1910, 120 3-year-old ashes were planted at 3 ft. intervals, and during that season the whole of the ground was kept free from grass or other weeds. On April 25th, 1911, the area was divided into two equal portions of 60 square yards each, and on one of them was sown a mixture of seeds comprising one oz. of each of the following: Crested Dogstail, Timothy, Red Fescue, Schroeder's Brome, Red Clover, White Clover, and Ribgrass, together with 8 ozs. perennial Rye-grass. This is approximately equal to 80 lb. per acre of the general mixture of seeds. The experiment therefore consisted of giving 120 ashes the same treatment for the first season, and subsequently of seeing what effect grassing over would have on 60 of them, the other 60 being kept free from weeds. The result on September 25th, 1912, that is after the grassing down had had two seasons to act, was that the plants on the grass-free area were much bigger and stronger than on the grassed area. Fig. 1 (Plate 5), from a photograph taken in the following winter, shows a tree in the centre from the grass-free plot, with specimens on either side from the grassed area.

In 1911, the first season of grassing, and in 1912 the average growth in height in inches was as follows :—

	1911.	1912.	2 Years.	Average Height of Trees.
With grass	29	23	52	85
Without grass	38	48	86	122

Even in the first year freedom from grass encouraged growth to the extent of 9 inches (31 per cent.) while in 1912 the difference averaged 25 inches (109 per cent.), that is to say, in the second year the growth on the bare ground was more than double what it was on the grassed area. At the end of 1912, when the trees were 6 years old—during two years of which time half of them were influenced by grass, while half were not—the average total height of the "grassed" trees was 85 inches, while that of the other lot was 122 inches, a difference, namely, of nearly 44 per cent.

In order to try to discover whether all grasses were alike injurious in their effects, and whether other plants had a similar influence on tree growth, 30 3-year-old ashes were put into 7-in. pots on February 14th, 1913. Each pot was placed on a saucer, so that it should be completely isolated from the ground. On May 27th, of the same year, the pots were divided into ten sets of three each, and certain seeds were sown as indicated below :—

No.

1. Surface of soil kept bare.
2. Grass mixture, not clipped.
3. Ditto, clipped weekly.
4. Ditto, plus White Clover, clipped weekly.
5. Sheep's Fescue, not clipped.
6. White Clover, not clipped.
7. Lucern, not clipped.
8. Gorse, not clipped.
9. Broom, not clipped.
10. Same as No. 1.

Effects of Grass, and certain other Plants, on the Growth of Young Ash Trees.

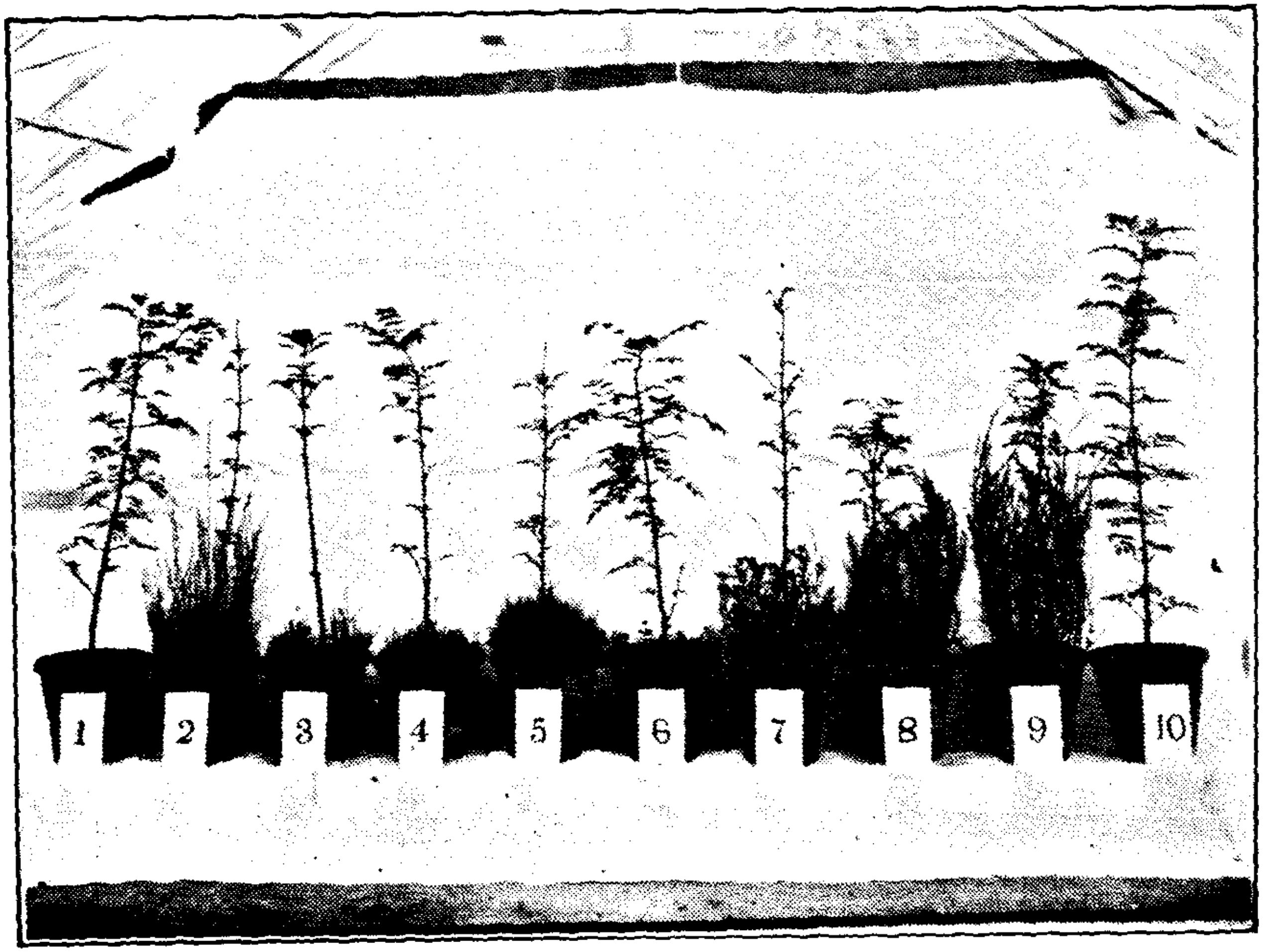

Photo.-Mechl. Dept. Thomason College, Roorkee.

Fig. 2—Ashes Growing in Association with Various Plants.

Effects of Grass, and certain other Plants, on the Growth of Young Ash Trees.

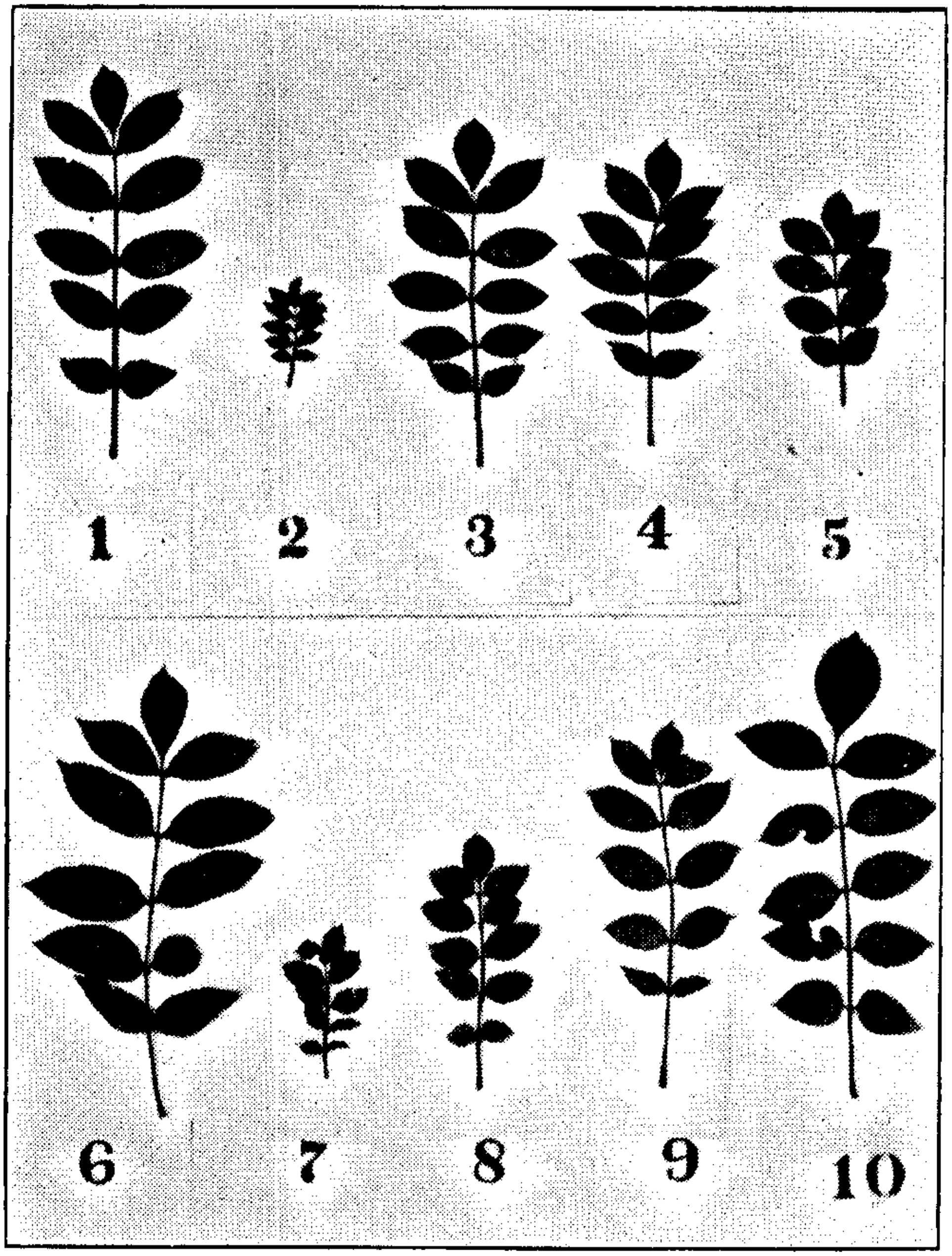

Photo.-Mechl. Dept., Thomason College, Roorkee.

FIG. 3. LEAVES FROM ASHES GROWN :—

1 and 10. On bare soil ;
2. In strong grass ;
3. ditto, but kept short ;
4. ditto, ditto, with white clover added ;
5. In sheep's fescue ;
6. In white clover alone ;
7. In lucern ;
8. In gorse ;
9. In broom.

The grass-seed mixture used in Sets 2, 3 and 4 consisted of equal parts of Tall Fescue, Perennial Rye-grass, Cocksfoot, Timothy, Foxtail, Tall Oat Grass, Meadow Fescue, and Smooth-stalked Meadow Grass. With the exception of the last-named species, these are all tall, strong-growing grasses. A very dwarf grass, Sheep's Fescue, was sown in the three pots of Set 5, and as it was allowed unrestricted growth during each season, it compares strictly with Set 2. The effect of adding a Leguminous plant, White Clover, to the general grass mixture was tested in Set 4, as compared with Set 3. It was also used alone in Set 6. Other three Leguminous plants—Lucern, Gorse, and Common Broom—were used alone on Sets 7, 8 and 9. The weekly clipping-over of the herbage was undertaken to ascertain the effects of restricted and unrestricted growth (compare 2 and 3). While the Gorse and Broom were not clipped over during the growing season, both these plants were cut down to the soil in the autumn of 1914, that is to say, when they were two years old. In 1913 water was kept constantly in the saucers up till the 16th of August, after which date the saucers were replenished only on Mondays and Thursdays. In 1914 and 1915 water was placed in the saucers twice a week throughout the growing season.

Fig. 2 (Plate 6) is reproduced from a photograph of one pot from each of the ten sets, taken on May 23rd, 1916, namely, at the commencement of the fourth season of growth; while Fig. 3 (Plate 7) is from a photograph of *the largest leaf* removed from the trees of the ten sets on June 8th, 1916.

A glance at Fig. 2 will show that, so far as height-growth is concerned, there is not a great deal of difference in the various sets. Nos. 1 and 10 are, however, the best, showing that in pots, as in the open ground, the ashes have thriven best where there was no interference by grass or other lowly plants. The Gorse (No. 8) and Broom (No. 9) have had the most restrictive influence on growth in height, so that it may be concluded that the nitrogen which these plants collected from the air failed to benefit the ashes. Broom, however, as will be seen from Figs. 2 and 3, was less injurious than Gorse.

But although growth in height was not greatly affected, there was a very marked effect on the size of the foliage (see Fig. 3); and the presumption may perhaps be allowed that but for the unnatural conditions of pot cultivation the ashes with the best foliage would have shown the best grown in height in the open ground. The largest and most healthy foliage was produced on Sets 1 and 10, where the trees were not associated with any other plants, and on Set 6, where White Clover was grown. This comparatively beneficial effect of clover is confirmatory of one result of the Woburn experiments. Lucern, on the other hand (see No. 7), had no such comparatively beneficial influence; in fact, the foliage of the ashes associated with this plant is almost as poor as that of those in Set 2, where strong grasses were allowed unrestricted growth.

The beneficial effects of the weekly clipping of the grass are clearly seen in Fig. 3 by comparing Nos. 2 and 3. Seeing that water was supplied in abundance to all the trees, the result can hardly be attributed to the effects of soil moisture, but is almost certainly due to the unrestricted grass plants of No. 2 exuding a larger amount of the poison—whatever it is—that reacts on the tree roots.

The addition of clover to Set 4 has been practically without effect, not because the clover is incapable of conferring benefit, but because its beneficial effects were counteracted in the presence of grass.

Comparison of Sets 2 and 5 will show that while Sheep's Fescue has been injurious, its pernicious effects are distinctly less than those of more strongly growing grasses.

The practical conclusions to be drawn from these experiments are:—

1. That superior growth will be got from such a tree as ash if, in its young stages, the ground is kept free from grass and other surface vegetation. Whether, however, the cost of hoeing will be recovered in the value of the improved growth can only be decided by further experiments. It certainly is a vital process in the cultivation of fruit trees.

2. If a plantation is hoed for a year or two after planting, it would appear to be desirable to sow a few pounds per acre of the seeds of White or Red Clover when the hoeing is stopped, rather than let the surface become covered with any plants that may accidentally establish themselves. This would appear to be a matter of some importance in orchard management.—[*Quarterly Journal of Forestry.*]

INTERNATIONAL TRADE IN MATCHES.

A survey of the world's supply and demand for matches has recently been issued from Swedish sources, and in view of the attention that has been drawn to this subject in former issues of the *Indian Trade Journal,* the following particulars supplied by the Canadian Trade Commissioner at Leeds to the Department of Trade and Commence at Ottawa, may prove of interest to Indian manufacturers.

The period from 1907 to 1912 is stated to have been a very unfavourable one, except, perhaps, to the Scandinavian makers. This unfavourable position was brought about by two causes, *viz.*, the lower markets and the greatly increased production of matches in different countries. It is asserted that during the period under review, most of the Finnish, Russian, German, Belgium and United States factories have worked on a very small margin of profit and in some cases even at a loss. More especially does this apply to the Belgian match industry, which, it is declared, has had to compete with ruinous prices.

COUNTRIES WHICH MAKE MATCHES.

The present position of the match industry as applied to the international supply and demand may be summarized as follows:—Sweden holds her former lead and has almost monopolized several of the most important export markets such as British and Dutch India. Norway holds second place for the output of matches and the third place can probably be claimed by Austria-Hungary, which country, before the war, had a fairly important export trade to the Balkan States and also to markets in Asia and elsewhere.

Germany, on the other hand, has made very little headway as a match exporting country; it has not been found possible to keep up the quality at the same level as that of Swedish and Norwegian matches. Furthermore, German manufacturers have found it impossible to compete with the abnormally low prices of really cheap matches such as are produced by the Japanese.

In regard to France, a match monopoly exists in that country, but as the largest factories are in the area at present occupied by the Germans, France is compelled for the time being to import matches. The same situation also applies to Belgium. In both Russia and the United States an extensive match industry is carried on and is protected in both cases by high tariffs but manufacturers find it difficult to compete to any appreciable extent on the international market.

The export of matches of United Kingdom manufacture is mostly confined to certain countries such as Australia where advantage is derived from a preferential tariff.

MARKETS WITH POSSIBILITIES.

Russia and the United States have hitherto presented no opportunity for Scandinavian matches owing to the extent of the home industries, but since the last tariff reduction came into effect in the United States, the export of matches to that country is increasing.

In the Levant, Austria has hitherto predominated, but owing to the war new possibilities have been opened up there. Excellent markets for matches are offered by British and Dutch India and the possibilities for further increasing the trade are distinctly good.

South America is regarded as a somewhat inferior market in view of the large production of a domestically made match of low grade, which is protected by high tariffs.

JAPANESE COMPETITION IN MATCHES.

The Japanese match manufacturers mainly control the Chinese market and on several important Asiatic markets keen Japanese competition has to be met.

The inception of the Japanese match industry dates back to about 1870 and the industry made particularly rapid strides during the two last decades of the nineteenth century. At one time Japanese-made matches seriously threatened the trade in the higher quality of European matches on the Indian market, but this competition has been successfully withstood.

SWEDISH MATCH TRADE AND THE WAR.

In connection with the foregoing survey the following extracts from the *Year Book* for 1914, recently issued by the Swedish Chamber of Commerce in London, will be read with interest :—

In British India, the Japanese competition has almost, and in Dutch India entirely, vanished, and also in other European colonies in Asia, Japanese matches have lost much ground. On the other hand, matches from Japan almost entirely monopolize the Chinese market. Japan has also succeeded in securing a share, though not a very large one, of the Californian trade since the reduction of the tariff in the same way as Scandinavian matches have begun to make some inroad in the Eastern States.

The war has tended to open out new opportunities for an extended market for the Scandinavian match industry in Germany and perhaps even more so in France and in the United States. The entire cessation of the Belgian export trade has naturally not been without its influence on the supply and demand in different parts of the world.

In reviewing the business done during the year, satisfactory progress has to be recorded, notwithstanding the difficulties created by the European war which commenced in the month of August.

The demand was very great from the beginning of September, and continued to increase owing to the fact that supplies from Austria, Belgium, Russia, etc., ceased.

Swedish makers have been doing everything in their power to meet the requirements of the market, but the difficulties in securing the necessary machinery, supplies of timber and other raw materials, to enable them to produce increased quantities, have been so very great that Swedish, as also British makers, have been

unable to take full advantage of the opportunity. In the last three months of the year the Swedish makers have done good business, and if they can only keep up, during 1915, the average monthly quantity of those three months, they will do a great deal to make good the total supplies which previously came from the Continental countries already referred to.

Prices have steadily increased, as indicated in our report for the year 1913, and it is evident that prices will be very high for a considerable period, and long after the war is over.

The costs of timber and other raw materials, freight, insurance, and other charges, have become so heavy that the selling prices of matches have had to be advanced from time to time to cover the increase in costs. Such changing conditions of the trade cannot be avoided, because of the exceptional circumstances created by the war.

It is quite impossible to anticipate the future, as the difficulties of shipping, as well as of securing supplies of timber, are giving manufacturers, Swedish, as well as British, very anxious times. A few small British makers have even had to stop making owing to the impossibility of getting supplies of timber and other raw materials.

Swedish manufacturers will, doubtless, do everything in their power to produce the quantities so urgently required for this market. If they are able to supply the extra quantity required, then the Swedish matches will hold a unique position in the British home market, both as regards quality and quantity, and, once secured, it will be very difficult for competitors afterwards to disturb this trade.

It is quite impossible to forecast the future under the shadow of a deplorable European war, but there are good grounds to hope for satisfactory results for the trade in the year 1915, if the manufacture can be kept up.

The above remarks will also apply to the trade with British Possessions. The prices have risen considerably since the outbreak of the war, and it cannot yet be taken for certain that they have reached the top. Owing to the total absence of supplies from

Belgium and Austria, and a considerable shortage from Japan, the demand in India has been concentrated upon supplies from Sweden and Norway, which countries are quite unable to furnish the quantities wanted. Everything tends to a shortage of matches all over the world, and the prices will necessarily be very high.—[*The Indian Trade Journal.*]

FRUIT.

THE EFFECT OF VARIOUS DRESSINGS ON PRUNING WOUNDS OF FRUIT TREES.

BY G. H HOWE.

An account of experiments, begun in 1911, with different substances on pruning wounds of fruit trees, in order to determine the effect of the various compounds in accelerating the cure of the injury and their preservative action against the attacks of fungi and injurious insects. These experiments have been made on apple trees (as representative of the pome fruits) and on peaches (as representative of stone fruits).

The following substances were employed: white lead, white zinc (both mixed with linseed oil), yellow ochre, coal-tar, shellac and *Avenarius carbolineum.* They were applied, at different times of the year, to pruning wounds of various sizes, some newly inflicted and others of some weeks' standing. The effects were observed, both in the case of the treated wounds and in that of those which were left open, at the end of the first and the second season of growth. The principal results were as follows :—

In all cases the untreated wounds healed more rapidly than those protected by any of the substances enumerated. Amongst the latter, shellac seemed, during the first period of growth, to exercise a stimulating effect on the development of bark around the wound ; this effect, however, ceased at the second period of growth. Shellac caused the least injury to the tissues of the cambium, but, on the other hand, it had the least adhesive power. *Avenarius carbolineum* and yellow ochre did so much harm to the cambium that, in the writer's opinion, they should never be used for

covering pruning injuries. The lesion produced by coal-tar was less serious, but this substance disappeared more quickly owing to absorption and evaporation. White lead and white zinc also produce a slight injury to the cambium tissues when they are first applied, but these tissues soon recover; and at the end of the first growth period hardly any trace of injury is left. White lead and white zinc were the most efficacious of all the compounds used, and the former was the better of the two.

Nothing is gained by waiting some weeks after pruning before applying the dressings.

All the substances used in the experiments in treating the pruning injuries of peach trees produce such damage to the wood that the wounds did not close. Consequently these substances should never be applied to the wounds of the peach; this probably applies to all other trees with stone fruit.

In no case were the wounds, whether open or protected, observed to be invaded by fungi. As the substances used seemed rather to retard the healing of the wounds, it may be concluded that the treatment of injuries to the wood is, to say the least, useless. Nevertheless, had the experiments been carried further, it is possible that they might have exercised a useful effect upon the healing of very large injuries; this however still remains to be proved.—BULL. INTERNAT. INST. OF AGRIC.—[Reprinted in the *Tropical Agriculturist.*]

DESTRUCTION OF TREES BY POISON.

ARSENIC AND SODA METHOD.

A subscriber wrote to *The Farmer and Settler* averring that arsenic was no good for tree-killing, as the trees suckered and the work had to be done all over again. The reply he received was that he had probably gone about the work in exactly the right way, but at altogether the wrong time. This paper has written literally hundreds of letters to landholders covering instructions for tree-killing; but has never known one failure in which there was not a certainty or at least a strong presumption that the

arsenic was used when the sap was active in the tree. There are other possible causes of failure, but farmers are too accustomed to following plain directions to be likely to err in any other particular than in the matter of season. And the reason they fail at this point is because it is not possible to indicate precisely when poisoning, to be successful, should be done.

The time for poisoning, as previously stated, is when the tree is dormant—that is, when the sap movement is at its minimum and the sap down in the roots and lower portions of the trunk. This occurs in the winter months.

The main object in catching the sap to season is to prevent suckering. Trees can be killed by poisoning or ring-barking at practically any time of the year, but to prevent suckering it is highly important to operate when the sap is down, or just completing its downward course.

An officer of the New South Wales Department of Agriculture has put into condensed form the experience of thousands of landholders, and he gives this advice as to how to set about poisoning timber as a quicker and cheaper method of destruction than ring-barking.

To Dissolve the Arsenic.

Ordinary arsenic is not very soluble in water, and soda—either in the form of washing soda or of caustic soda—has to be used to dissolve it. Ordinary washing soda requires to be used in the proportion of three of soda to one of arsenic, and boiling is necessary to bring about a complete solution. Caustic soda, which is much dearer, need only be used in the proportion of two of the soda to one of arsenic, and the heat generated, if a reasonable amount of water is added, is sufficient to obviate the necessity for boiling. For large quantities, washing soda is preferable, because the cheaper, but for small quantities, caustic soda is perhaps better because it is handier.

The Mode of Operation.

In dissolving the arsenic, whether for washing or caustic soda solution, there is one point worth remembering: Do not tip the

whole of the arsenic into the solution in a dry state, but mix it to a paste slowly and carefully, in the same way as the housewife treats her cornflour; then pour it slowly into a solution of the soda, stirring it all the time, and being careful to stand away from the fumes, as they are poisonous. When once the soda and arsenic are dissolved and chemically combined, the balance of the water can be added to make up the required quantity.

A useful strength for quick and effective work in all kinds of timber is a solution prepared on this formula: Arsenic, 1 lb.; washing soda, 3 lb.; or caustic soda, 2 lb.; water, 4 gallons; whiting, 1 lb. The whiting serves as an indicator on the trees treated, as it turns white on drying, making it quite certain what trees have been dealt with. An empty kerosene tin makes a useful measure for dissolving in, as it holds 4 gallons.

The tree that is to be operated upon is first rung with a "frill" ring. There is no doubt that "frilling" alone would kill timber if allowed time, but the poison does it in a fraction of the time—in fact, trees have been killed in a few days. The cuts must be through the bark and well into the wood proper, and they must be as close to the ground-level as it is convenient to make them, consistent, of course, with the shape of tree; say, from 6 in. to 10 in. up.

For trees of 4 ft. diameter about a quart of solution is poured into this frilling, right around the tree, using an old tea-pot or kettle, as the spout makes pouring easy and less is wasted by spilling. Smaller trees, of course, need less solution.

Saplings may be cut off low down, and the solution may be dabbed on with a swab stick to kill and prevent suckering.

It is very important that this frilling and poisoning be consistently and thoroughly carried out, and not in any way scamped or slummed if good results are to be looked for.

No fears need be entertained about stock being poisoned by eating the fallen or dead leaves from treated trees, and there is not much danger if they are even allowed to remain on the area; but to make sure it is desirable that all live-stock should be excluded for three or four weeks.

THE QUESTION OF COST.

Estimates of cost are hardly likely to be of use, as there are several factors that vary with the district. A recent report of the manager of the new Condobolin Government demonstration farm records that poisoning was adopted there with success and economy. The work was done by day labour at a total cost of 1*s.* 5*d.* per acre. This must be considered very low, as the country was fairly heavily timbered, and the wages were from 1*s.* to 1*s.* 4½*d.* per hour. Said the manager: "The timber has all died, and mostly within forty-eight hours from the time of ringing."

The liquid was distributed by means of 1½ gallon watering cans with spouts made specially long, and having exit holes about the size of a No. 8 wire.—QUEENSLAND AGRICULTURAL JOURNAL. [Reprinted in the *Tropical Agriculturist.*]

VOLUME XLIII NUMBER 3

INDIAN FORESTER

MARCH, 1917.

COMMERCIAL *VS.* QUASI-COMMERCIAL DEPARTMENTAL TEAK EXTRACTION IN BURMA.

(*Contributed.*)

Departmental extraction in teak has of late years begun to take a new lease of life.

After many years of neglect, during which the revenue it brought in to Government was looked upon as being in the nature of a natural phenomenon by the higher powers, and the labour it entailed on forest officers as being a natural plague comparable to stink bugs or any other seasonal visitation, it has been gradually recognized that departmental extraction is more than a Quasi-Commercial enterprise, that it is, in fact, wholly commercial. This enlightenment has so far only reached the lower strata of those concerned with the work. The Quasi-Commercial, or wholly Uncommercial, idea still abides in the regions where provincial budgets and allotments are framed.

Departmental extraction is still considered as a side-show of forest work in Burma. It seems that the extraction, transport and

measurement of some 20,000—30,000 logs per annum can easily be sandwiched in between, and is indistinguishable from, the carrying out of the various silvicultural works and the control of general revenue.

How great the difference is between these main branches of work can only be appreciated from the inside, by the "toad beneath the harrow."

Whatever the rest of forest work may be, departmental extraction is commercial and nothing else, and unless we choose to postulate that it is philanthropic, psychologic or anything else but commercial, the only thing to do is to try and conduct it on commercial lines. To do this means that there must be a big break away from our present methods in finance and organization of the work.

Let us consider finance. In a commercial concern one of the first considerations is to know how much actual profit or loss there is on the working, and whether the results of the work are commensurate with the money invested in the enterprise.

At present we know nothing about the capital invested. Our methods of accountancy would make it appear that each year's work is a complete, separate and isolated undertaking in itself and that no capital is, or ought to be, invested in teak extraction. Surely, there is something uncommercial in that. Then, again, why should the cost of timber elephants be mixed up with those used for general transport, or the cost of stores be thrown into the general heap?

A number of examples of similar anomalies can be seen every month in the accounts of divisions where departmental timber work goes on.

The most glaring example of our uncommercial finance is the question of lapsing grants.

What commercial concern on earth would lay down that a work, for which money has been provided, must not be done at all, or must remain unfinished if the money set aside for it has not been spent by a certain date? Yet such is what ought to happen if we adhered to the letter of the law.

The institution of a capital account with funds allotted as capital permanently and directly available for employment in departmental extraction is of the first importance. Without it there can be no steady development, and we shall never know whether our work is sound or not.

The next need is a separation of the accounts of departmental extraction from the general accounts of the forest division; otherwise, we cannot judge whether we are keeping up to standard, progressing or falling back.

Several years of bad management might easily pass unnoticed in our present accounts, which would spring at once to the eye were the accounts kept separate.

A natural corollary of the above-mentioned two changes is that the allotment of funds or current work must be dependent on actual needs of the undertaking, and not on general conditions of the provincial finance as a whole. If the output of logs in Zigôn is to depend on the size of the education grant in Myitkyina in any particular year, the sooner departmental extraction is given up the better. Run commercially, departmental extraction will be able to stand on its own feet. As run at present, it is only by local officers disregarding rules and taking risks which come by no means within their articles of agreement that it is kept alive. Two years' strict adherence to the rules would see the present output halved, five years would see every contractor up to his ears in debt to the chetties, and at the end of ten years there would not be a single contractor left worth having.

Let me give an example to illustrate this. In one division, the advances to contractors for working expenses amount, at one time of the year, to about Rs. 30,000; the tangible security available for these advances does not amount to more than Rs. 10,000.

The Divisonal Forest Officer is therefore personally liable for Rs. 20,000. True, nearly the whole of the Rs. 30,000 is recovered before the end of the year, and Government explains unofficially that the Divisional Forest Officer would not usually be held responsible in the case of an advance proving irrecoverable.

This is very interesting and consoling, but suppose the Divisional Forest Officer were to say, "Thank you, but I prefer to stick to the letter of the law."

He would only advance Rs. 10,000, and the contractors would have to go to the chetty for the balance, or more likely would give up the business altogether. In either event the end is the same, the contractor disappears sooner or later, and his outturn with him. Good contractors are not to be picked off every bush.

In a commercially run enterprise, provision is made for the conditions of working, and bad debts and irrecoverable advances are allowed for as a matter of course.

The other main consideration is the organization of the work and the staff. Great strides have been made in this direction already. The change for the better is very evident to those who know the old uncontrolled departmental extraction of ten years ago, but we are still a long way from the goal. The chetty has been got rid of, as chief controller of extraction, but his disappearance has landed us in other difficulties. Now, Government offers to find the money for contractors to purchase elephants, but demands that the contractor shall pledge security to one and a half times the amount of advance. This condition makes it almost impossible for a new contractor to begin work.

Before he can hope to make a decent profit, he must possess three elephants, costing at least Rs. 5,000 each, *ergo*, he must own security to the tune of Rs. 22,500.

Very few men, owning that amount of property, would care to risk it in a business which needs them to lead a hard jungle life, and in which they may see all their capital swept away in a year, through no fault of their own. There are various solutions to the problem, which are too intricate to go into here, but all require that there shall be capital to put into the business by Government, and that Government shall take ordinary Commercial risks.

Next comes the question of charge and staff. At present, the control of extraction is in the hands of the Conservator and the local Divisional Forest Officer with his Timber Assistants. All are

subject to transfer at short intervals, and had probably had no experience of timber work before taking up the charge.

Both the Conservator and the Divisional Forest Officer have their ordinary routine work, so that the time they can give to timber work is small. The staff of Timber Assistants is small—far smaller than the staff of a timber firm would put into the same area.

In the case of the Pegu Circle the timber staff, small as it is, overlaps in many cases. Logs from Prome Division are dealt with by four divisions before they reach the market. Zigôn logs are handled by three divisions, and the Tharrawaddy logs by two. All these logs come into the market by one route. How much simpler it would be, if the logs, from stump to market, were under one control.

Now there are three different Divisional Forest Officers with three separate staffs and three sets of accounts, contracts and clerks all tackling the same business, yet the total area is not as large as many of the timber leases. Worst of all, each individual is an amateur at the business. In other branches of forestry, no officer is expected to become an expert in two years, yet three years is about the average service (in any one of the above divisions) of a Divisional Forest Officer or Timber Assistant, neither of whom has had any previous experience of the work, and will very likely never come across it again in his service.

The question of expense crops up at once. An increase in expenditure there must be of course, which at the start should not amount to more than the pay of one Divisional Forest Officer and four more Assistants with, say, six extra clerks in all. Actually the principle of an increase in the number of Timber Assistants has already been accepted, so that only the extra Divisional Forest Officer and his office remains to be thought of. Against this, may be set an estimated saving of one lakh a year by better management, and a minimum increase in output of 3,000 logs per annum worth between two and three lakhs.

Against the above alterations in organization may be urged the difficulty of getting a supply of men to carry out the work.

This could be solved by recruiting a staff, without technical forest training, in the same way that the large timber firms recruit their staffs. A technical forest training is not indispensable for timber extraction work. Men with a good ordinary education and possessed of the self-reliance and initiative, which is usually got from an average public school training, are all that is required, and, of these, there seems to be an unfailing supply at home.

One point must, however, be clearly marked. Timber work has no place for wasters and "dhobi-markers," and, for this reason, timber work cannot be run commercially if the current principle holds that once a man has been appointed to Government service he has an inexpugnable claim to the pay and prospects of his service, however little he may work, provided he does not bolt with the cash balance.

If a separate timber working staff is started, its conditions of service should be the same as those of the timber firms. It should be unpensioned, but allowance should be made for this under a Provident Fund scheme. It may cost more at the time in cash, but the indirect saving is obvious. Slack work means few logs and dear. No forest officer needs to be told what a skilled and determined loafer on the pensioned permanent establishment means. Government loses indirectly lakhs every year through such men, but the loss is not felt in the general profit shown every year by the Forest Department. In timber work the loss will be felt acutely. Good pay, good treatment, a good Provident Fund and a month's notice are the four corner stones of timber work and on them must rest every part of the service—superior, subordinate and clerical.

To sum up conclusions: the time is getting ripe for the separation of the purely Commercial side of forestry in Burma, from the administrative and preservative sides. To do this, the finance of the Commercial side requires to be made Commercial instead of statistical, and the staff for the Commercial work needs to be made expert, and to be ruled by Commercial principles. A Quasi-Commercial enterprise is neither fish, flesh, fowl nor good red herring.

HTAO HAI.

THE FORMATION OF TEAK TAUNGYA PLANTATIONS IN BURMA.

BY J. D. CLIFFORD, I.F.S.

Mr. C. W. Allan's article on the teak taungya plantations of the Henzada-Maubin division, that appeared in Vol. XLII, Nos. 11 and 12 of November and December 1916, raises questions of considerable importance. In addition to some inaccuracies, such as his statement that the number of plants* 6′ × 4′ to the acre is 1,210, the method of counting described is not to be recommended. That a gazetted officer should be required to stroll up and down 240 feet of taungya line, whilst 40 coolies are counting under the supervision of "a forest subordinate behind every five or six men," strikes me as a waste of that gazetted officer's time and that of seven or eight subordinates also. He cannot possibly carry out any efficient check in so doing, though perhaps the actual coolies he may have his eye on, from time to time, will refrain from calling out 'dead,' instead of 'alive,' at the particular moment. The only check of any value is for the gazetted officer, when he wishes to test the accuracy of countings, to carry out re-counts over selected areas. With efficient subordinates, few re-counts will be found necessary. The method of counting described in the ensuing paragraph has been carried out for some years with satisfactory results.

Method of Counting—

Counting the number of seedlings in a 'ya' may be carried out by the Beat Officer, and the work checked by the Range Officer, whilst the seedlings still retain their leaves, *i.e.*, in the cold weather before the beginning of the fire season. Before starting work, the owner of the 'ya' must be made to peg out the planting distances completely over his 'ya,' irrespective of whether the seedlings are alive, dead or absent. Twelve to twenty coolies are as many as can be properly supervised by one subordinate; but, if sufficient coolies are forthcoming, two subordinates can manage a gang of twice the number. The coolies should work in pairs, two men to each row of seedlings, a front man and a back

* Since corrected by Mr. Allan to 6′ × 6′, *vide* his letter under head "Correspondence" published in this paper.—[HON. ED.]

man. When each pair has been allotted a row, the pairs should all move forward at the same time and preserve a straight line as they go along. The front man of each row, as he gets to a planting stake, calls out 'alive,' or 'ashi,' or 'dead,' or 'athé,' according as to whether there is a live seedling at the stake, or a dead one or none at all. In the case of the dead one, or absent one, the front cooly picks up the stake and retains it, and in the case of live seedlings he pulls out the stake and lays it on the ground by the seedling. The back cooly is provided with several bamboo tallies, most of them green but some of them white. Each time the front cooly calls out 'ashin,' the back cooly bends a nick in the green tally; and each time, 'athé,' he bends a nick in the white tally. At the end of each row, or two or three rows if they are short ones, all the pairs halt. The enumerating officer then notes in his book the numbers of live or dead seedlings recorded by each pair and sees that the number of nicks bent in the white tally is the same as the number of stakes held by the front cooly. It is thus impossible to count the same area twice, as the stakes will be all pulled out over the counted area. Moreover, if there is reason to suppose that the coolies are not doing their work properly, the number of bent nicks in the green tally can be checked occasionally, by going back over the row and counting the stakes lying on the ground. Each time the numbers are recorded in his note-book, the enumerating officer should see that the stakes are dropped, and all bent nicks broken off before starting on fresh rows. Marking on a piece of bamboo with the thumb nail, as described by Mr. Allan, is apt to lead to inaccuracies. The tallies consist of pieces of bamboo about $\frac{1}{8}$th inch thick, split except at one end into ten strips, each about $\frac{1}{8}$th inch in width. Before splitting ten parallel nicks, each a quarter of an inch or so apart, are made on the bamboo so that each tally will do for 100 plants.

Density—

I think I am right in saying that most of the existing taungya teak plantations in Burma were either planted 6′ × 6′ or 12′ × 3′. The probable reason for planting 12′ × 3′ was to facilitate weeding, but the disadvantage of such planting is obvious

Scale—1 Inch = 12 Feet ($\frac{1}{144}$).

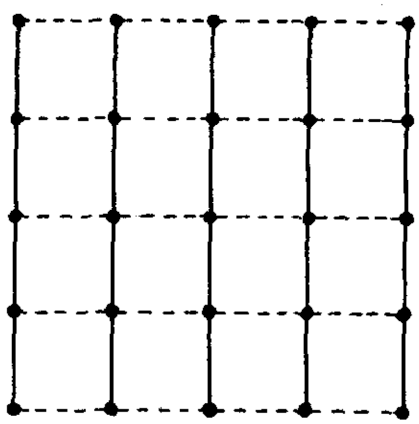

Fig. 1.

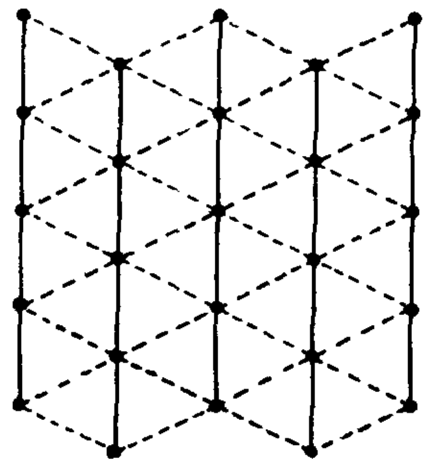

Fig. 2.

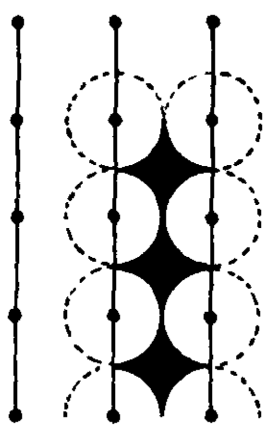

Fig. 3.

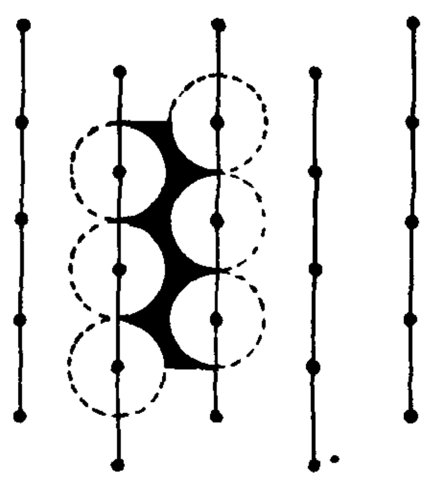

Fig. 4.

Formation of Teak Taungya Plantations in Burma.

in many plantations, especially in the many that have been thinned very lightly or not at all, where the narrow elliptical shape of the crowns shows clearly that expansion has been in two directions only, instead of evenly all round. In many 6′ × 6′ plantations, the leaf-canopy has been complete by the fourth year, and, in older plantations, there is no doubt that the crowns are better than in the 12′ × 3′ plantations. It seems desirable that the present practice of planting 6′ × 6′ should be adhered to, at least until the Forest Research Officer's experiments show other planting distances to be suitable.

When the area is first pegged out, instead of placing a stake at the beginning of each line, as is generally done, it is better to advance the first stake a distance of 3 feet in every alternate line. This will secure all the benefits of almost equilateral triangular, instead of square, planting, is almost as easy to carry out and does not appreciably affect the number of seedlings per acre. This can be seen at a glance in the diagrams (Figs. 1 and 2, Plate 8).

Assuming that the crowns of the young trees expand equally in all directions, as is silviculturally desirable, the benefits of the triangular planting, still 6′ × 6′, as far as the coolies are concerned, are clearly shown by diagrams (Figs. 3 and 4, Plate 8). In each case the area of ground uncovered when the crowns begin to touch each other is the same (8 sq. ft. approximately in every 36 sq. ft.), but obviously in Fig. 4 the leaf-canopy will be complete earlier and the crowns a better shape than in Fig. 3.

I do not remember having seen any plantations 6′ × 4′ as mentioned by Mr. Allan, but can imagine no advantage of thus increasing the number of plants per acre, since the leaf-canopy of 6′ × 6′ plantations is complete with efficient weedings at a very early age.

Cost—

That the initial costs of artificial regeneration must be kept at the lowest possible figure admits of no argument. In Burma, custom has decreed that the taungya-cutter shall be paid at the rate of Re. 1 per hundred staked seedlings found alive at the time of counting. I believe that, in many divisions, there is no need to pay this rate. Where there is competition to get land for a

taungya crop, the rate might be reduced considerably and, if competition is sufficient, dispensed with altogether. The taungya-cutter is often not dependent on the amount the Forest Department pays him, though it is useful no doubt for paying his 'thathameda' and obviating the necessity for his doing any work for a few months after. The value of the crop taken off the land suffices for the ya-cutter in unclassed forests and would often do so in reserved forests too. In any case, there should be a material reduction in rates for non-success in re-stocking. I would suggest that when the density is under ·5, no payment whatever be made, over ·5 and up to ·6 half rates, over ·6 and up to ·8 three-quarter rates, and the full rates only paid when the density is over ·8. If the taungya-cutter clearly understood this, he would take greater care to fill the blanks with small transplants early in the rains and to protect the seedlings from being choked by his crop as well as by weeds.

As regards weeding and cleanings, which Mr. Allan just refers to, much depends on the intelligence of the subordinate in charge. Having to be done in the rains, these works often do not get the attention their importance warrants; but these two operations, to be dealt with in detail, would make this article of undue length.

Preparation and burning of site—

The earlier the ya-cutter can be induced to fell all growth on the area, the more satisfactory will the burning be. Any trees containing marketable timber should be felled, logged and dragged outside the area, during the preceding rains, which is the best time therefore for the selection of the site.

In Fig. 4 (Plate 51, Vol. XLII) of Mr. Allan's article are to be seen two dead standing trees, for which presumably the ya-cutter or beat officer was fined. Burning will not always be complete, since large boles cannot get dry enough in so short a time: there is, however, no excuse for any tree being left standing on the area, and for any felled trees not lying flat on the ground, with all branches lopped off and burnt, a small fine is to be recommended. This amount can be deducted from the sum paid per hundred plants, and would tend to make the ya-cutter take more trouble in burning future areas.

The success of the plantations Mr. Allan refers to is probably, in a great measure, due to his insistence on the teak seed being dibbled in before the first week of May. Late sowings, in June and July, if the taungya-cutter is not watched, result in a much smaller percentage of germination in the first rains, and also in short weakly seedlings, many of which do not survive the following hot season.

Size of Teak Taungyas—

A minimnm size of 25 acres has been fixed (*vide* C. C. F.'s Circular No. 9 of 1915), but no maximum limit has been prescribed. Since we have as yet no mature plantations, it is not possible to ascertain to what extent we shall pay the penalty for growing this crop pure, though, from evidence recently collected, there is reason to anticipate considerable damage from at least one species of wood-borer. Many plantations in the forests of the Pegu Yoma include almost flat and swampy ground at the bottoms of the slopes, and stop short half way up slopes, or on the crests of the ridges. This points to the ya-cutter's choosing his own site, good soil no doubt for his own crops but not always the best for teak. It is in these flat and damp hollows that wild elephants break so many saplings and poles and where unhealthy teak prevail. If the ya-cutter clears such areas at all, he might well be instructed not to sow teak on them, and thus isolate plantations. He might also be made to clear ridge crests and slopes on both sides, leaving belts astride the ridge, 150 feet or so in width, to divide up the blocks still further. Until we know more of plantations, perhaps it would be advisable to limit each block to thirty acres. I have recently seen young plantations considerably over 100 acres in extent, which, had they been isolated, blocks of about thirty acres or so would have more truly conformed to silvicultural principles.

A NOTE ON SAL TIMBER OPERATIONS IN SINGHBHUM, BIHAR AND ORISSA.

BY O. A. DODSWORTH, P.F.S.

I have recently been engaged in compiling some statistics on the outturn of timber, from the coupes leased out to Messrs. The Bengal Timber Trading Company, Limited, in the Singhbhum Division, of the Bihar and Orissa Circle. The results so obtained may possibly be of interest to some of your readers for comparison with the yield of timber of other Sal forests. Also, results of calculations obtained from these figures, together with the rate of growth of trees ascertained from the existing Sample Plots, will corroborate the statement made by Mr. Troup regarding the economical exploitability of Sal at a smaller size than has hitherto been accepted.

2. Before going into details, it would be as well, perhaps, to describe briefly the method of work and local conditions in these forests.

3. The Working Plan in force at present prescribes Selection combined with Improvement fellings as the system of treatment. The possibility is by area, and the number of trees, to be marked in each compartment, is left to the discretion of the Marking Officer, who is guided by a set of carefully drawn out marking rules.

4. The Working Plan further classifies the forest into two main divisions, *viz.*, Hill Type and Valley Type. The area of the former is vastly in excess of the latter. The conditions of growth in the two types is very distinct. There are, of course, intermediate stages, where one type passes into another. In the Valley Type, where the soil is deep and fertile, the Sal grows to a great height, and reaches a girth of sometimes 10 to 12 feet. In many of the deeper and extensive valleys, the growth of Sal is second to none in India. In the Hill Type, owing to the poorer nature of the soil, the growth is generally stunted, and timber unsound. The marking has, however, been carried out throughout both types.

5. The exploitable size has been fixed at 6 feet girth in the Valley Type, and 5 feet in the Hill Type, but sound healthy trees

growing in the very best of localities are left to attain a larger girth increment.*

All badly shaped, unsound and diseased trees, below 6 feet girth, are also marked for felling.

6. In the existing stock, the proportion of unsound trees is rather high. Unfortunately, no record has been kept showing unsoundness at stump, and it has only been possible to obtain percentages in the case of those trees which have proved, due to unsoundness and defects, absolutely inutilizable from a timber point of view. The proportion of such trees in the different girth-classes is as follows :—

4′ to 4½′ girth	...	...	40 per cent.
4½′ to 5′ ,,	...	...	37 ,,
5′ to 5½′ ,,	...	...	23 ,,
5½′ to 6′ ,,	...	...	24 ,,
6′ to 6½′ ,,	..	...	26 ,,
Over 6½′ ,,	...	...	25 ,,

There is no doubt that unsoundness, in the larger girth-classes, is much more frequent; but, due to their greater size, some portion of the tree has been utilized and entered as "sound" in the registers. Hence the above proportions cannot be taken as describing the actual condition of the stock accurately.

7. The Marking Officer keeps a register of the girth of each tree marked, and at the same time serially numbers each tree in a compartment.

8. When the tree is felled and converted, the number of the tree is noted, and the total outturn from the tree recorded in the outturn register of the coupe maintained for the purpose. The outturn statement cannot be said to be very correct, owing to the fact that the staff employed on recording the yield of timber in the coupe is not always reliable. It is hoped, however, that, owing to the extensive nature of the fellings, any slight defects in the original records will not make any appreciable difference in the general conclusions.

9. The Bengal Timber Trading Company have now been working in these forests since the year 1909. The first lease

* Mature trees according to the Plan should only be left to provide against blanks.—[ED.]

obtained was for a period of five years. The terms were extremely favourable to the Company, as timber works in remote forests of the Division were in a more or less experimental stage. Some of the more special points of the lease were—

(1) The lessees are bound to fell and convert every marked tree that will yield a sleeper.

(2) Every tree felled must be converted to its utmost capacity.

During the first few years of this lease, the coupes were not worked fully; many of the marked trees were left unfelled and the material from the felled ones was not converted to its fullest capacity. Much waste consequently resulted. Towards the latter part of the agreement, matters were much improved, and a closer supervision and control exercised over the work of the Company. On expiry of the five years' term, a fresh lease was granted for a further period of three years, and the coupes which were not completed in the old lease were again given out. Some new rules were added to the agreement, and the rates of royalty enhanced.

10. The class of material removed from the forest consists entirely of Railway sleepers, which the lessees have contracted to supply to our Indian Railways.

11. Since the time the records of exploitation have been kept up, a total area of 12,771 acres has been worked over (excluding those coupes which are now under exploitation, and those for which records are not available), and approximately 23,396 trees felled and converted, yielding a total volume of about 569,464 c.ft. of Sal timber valued at Rs. 3,26,106. The royalty charge per sleeper is as follows :—

Description and size.	In old lease.	In new lease.	REMARKS.
	Rs. a. p.	Rs. a. p.	
Broad gauge 9′ × 9½″ × 5″ ...	1 9 0	2 5 10	
Metre „ 6′ × 8½″ × 4½″ ...	0 9 0	0 13 0	
Narrow „ 5′ × 7″ × 4½″ ...	0 6 0	0 7 10	
Per c. ft. of scantling, containing less than 4 c. ft.	0 7 6	0 11 4	Per c. ft.
Per c. ft. of scantling, containing more than 4 c. ft.	0 8 6	0 12 4	Per c. ft.

12. From the figures obtained from the outturn registers of the coupes, and rate of growth of trees ascertained from Sample Plots, a calculation has been made as to the most suitable and economical size for felling trees.

13. There are not many Sample Plots in this Division and some of them are, perhaps, not well chosen as representing the type of forest for which intended. The figures of the outturn register have been prepared in 6-inch girth-classes, for trees of 4 feet girth and upwards, and so the same classification has been adopted in ascertaining the rate of growth.

14. The following are the results of measurements taken in five Sample Plots for varying terms of years between 1891 and 1915 :—

Girth-classes.	Under 4′.	4′ to 4′ 5″.	4′ 6″ to 4′ 11″.	5′ to 5′ 5″.	5′ 6″ to 5′ 11″.	6′ to 6′ 5″.
Number of trees measured	110	36	50	25	1	2
Average annual girth increment.	·41	·41	·42	·47	·58	·77

From these figures the following results are obtained :—

Girth-class 0′ to 3′ 11″ (average 2′) a tree takes 51/·41
= 124 years to grow from 0′ to 4′ 3″.

Do. 4′ to 4′ 5″ (average 4′ 3″) a tree takes 6/·41
= 15 years to grow from 4′ 3″ to 4′ 9″.

Do. 4′ 6″ to 4′ 11″ (average 4′ 9″) a tree takes 6/·42
= 14 years to grow from 4′ 9″ to 5′ 3″.

Do. 5′ to 5′ 5″ (average 5′ 3″) a tree takes 6/·47
= 13 years to grow from 5′ 3″ to 5′ 9″.

Do. 5′ 6″ to 5′ 11″ (average 5′ 9″) a tree takes 6/·58
= 10 years to grow from 5′ 9″ to 6′ 3″.

Do. 6′ to 6′ 5″ (average 6′ 3″) a tree takes 6/·77
= 8 years to grow from 6′ 3″ to 6′ 9″.

From an average curve obtained from the above figures, the following table will show the rate of growth in girth based on measurements of 237 Sal trees :—

Girths corresponding to different ages.			Ages corresponding to different girths.			
Age. Years.	Corres. girth. Ft.	In.	Girth.. Ft.	In.	Corres. age. Years.	REMARKS.
30	1	0	1	0	30	1. The plots are in natural unthinned forest. The rate of growth is slower than would be the case in crops regularly tended and thinned. The shade of over-mature, hollow and diseased trees is responsible for the low rate of growth of the lower girth-classes.
40	1	4	1	6	44	
50	1	9	2	0	59	
60	2	1	2	6	73	
70	2	5	3	0	88	
80	2	9	3	6	102	
90	3	1	4	0	117	
100	3	5	4	6	132	
110	3	9	5	0	146	
120	4	1	5	6	160	2. Nothing has been added for the time required for a seedling to establish itself.
130	4	5	6	0	171	
140	4	9	6	6	180	
150	5	2	...		...	3. The measurements are not sufficiently numerous to be thoroughly representative.
160	5	6	...		...	
170	5	11	...		...	
180	6	6	...		...	

15. Knowing the rate of growth of trees, and the value per tree from the outturn registers, it has been possible to make calculations of the present value of trees of different girths.

$$\text{Formula P. V.} = \frac{C_n}{1{\cdot}op^n - 1}$$

$$P. = 3\tfrac{1}{2}\%$$

Girth-class.	Mean age.	Average value per tree.	Present value per tree.	REMARKS.
Ft. In. Ft. In.	Years.	Rs. a. p.	Rs. a. p.	
4 0 to 4 5	124	7 9 0	0 1 8·6	
4 6 ,, 4 11	139	9 0 0	0 1 2·6	
5 0 ,, 5 5	153	12 0 0	0 1 0	
5 6 ,, 5 11	166	14 0 0	0 0 8·9	
6 0 ,, 6 6	176	17 10 0	0 0 8·0	

16. There are not sufficient figures available to calculate the financial rotation, but the above calculations amply justify the lowering of the exploitable size from 6 feet girth. Under existing conditions, it is practically only the larger girth-classes that enjoy full light, the result being that the increment of the larger trees is greater than that of the smaller. If the exploitable size were reduced to 5 feet girth, the increment of the girth-classes below 5 feet would be much greater than it is at present, with a resulting rise in the present value of the lower girth-classes. From general observations, it is noticed that the majority of the trees become unsound, after reaching a girth of about 5½ to 6 feet. It will certainly be the case that there will be much fewer sound 6 feet trees than 4 feet or 5 feet trees per acre.

Moreover, the present value of the cost of cleaning operations would prove greater in a longer rotation than in a smaller. It seems, therefore, from the above facts that, under the present Selection system, a smaller rotation should be adopted with financial advantage.

17. If a conversion is made to a more even-aged system, a reduction in the rotation would prove still more advantageous, as the increment of the lower girth-classes would be still greater.

The 5 feet-girth tree satisfies all economic demands, and so, for the present, it would prove safer not to lower the rotation below what will yield a tree of 5 feet girth.

PROGRESS OF THE CASUARINA PLANTATIONS IN WESTERN DIVISION, KANARA.

(A Paper read at the last Bombay Presidency Forest Conference.)

BY G. E. MARJORIBANKS, DIVISIONAL FOREST OFFICER, KANARA, WESTERN DIVISION.

1. The total felling, with volume and revenue, are shown up to 1915-16 compared with the Working Plan prescriptions, starting from 1909-10 :—

	Working Plan prescriptions and forecast.			Actuals.		
	Acres.	Volume c.ft.	Revenue. Rs.	Acres.	Volume. c.ft.	Revenue. Rs.
Kodibag	39·3	133,620	15,720	39·3	182,798	16,885
Arghe	7·5	23,625	3,000	7·5	23,738	850

Note that the price per acre in Kodibag is Rs. 430 as against the Working Plan estimate of Rs. 400, and the heavy drop per acre to Rs. 114 in Arghe. The coupe just sold for 1916-17 in Arghe has fetched a similarly low price. The Kodibag wood averaged 39 years old as against 30 in Arghe, but the drop is due chiefly to poor quality of the growth, and the inconvenience of the bunder and locality generally, compared with Kodibag.

2. *Thinnings.*—The only regular thinnings which have become due were carried out in about 12 acres of the 10, 11 and 12 year-old plantations in Kodibag. The results are given below. No thinnings are due till next year in the other plantations.

Trees felled.	Poles.		Fuel.		Brush-wood heaps.	Financial results.		
No.	Prepared. No.	Price. Rs.	Prepared. c. ft.	Price. Rs.	Price. Rs.	Rev. Rs.	Exp. Rs.	Net Rev. Rs.
394	159	124	2,907	273	38	435	51	384

Note that the net price of poles is annas 12 each. This is of mportance in considering para. 8 below.

The sale of brushwood nearly covers the cost of the thinnings. It has to be remembered that everything from Kodibag plantations can be profitably sold, which is hardly the case at Chitakule, and not at all the case at Arghe.

3. *Cleanings.*—These have consisted of removing stumps, suppressed, dead and fallen trees and pruning lower branches. The results to date are as under :—

	Rev.	Exp.	Net rev.	Remarks.
	Rs.	Rs.	Rs.	
Kodibag	686	460	226	Considerable numbers of trees died in the exposed north end of the Kodibag plantations.
Chitakule	283	79	204	
Arghe	(No operations have been recorded.)			

4. *Planting.*—The areas planted to date, since introduction of the Working Plan in 1909-10, are compared with those prescribed and the cost shown below :—

Name of Plantation.	Working Plan.	Actually planted.	Total Cost.	Cost per acre planted.
	Acres.	Acres.	Rs.	Rs.
Kodibag ...	39·3	38·8	2,643	
Chitakule ...	73	61·2	3,774	62
Arghe ...	..	32·5	2,673	82

The shortage in Chitakule is due to each year's planted area not being measured at the time; the deficiency is being made good by extra planting now.

The blank area in the south end of Arghe was apparently planted up to prevent the land lying fallow.

It will be seen from the above that, the Working Plan prescriptions have been nearly worked up to, and that, so far as Kodibag is concerned, the financial results have exceeded the estimate and are satisfactory, while in Arghe they are very far below it. No felling has been done in Chitakule yet.

5. To revert to thinnings, two officers are of opinion that, the age of 10 years, at which they are prescribed to begin, is too high

and that, the first thinning should be made at 6 years. I do not think this is proved. Although Casuarina is highly light-demanding, the vigour and persistence of the lateral branches seem to call for its being kept close-grown for a considerable time. Again, it is undesirable that trees should be thinned, while their principal height-growth is far from being reached. Cleaning of dead and fallen stems, too, account for a considerable number of trees up to 10 years' age, as will be seen from the figures in para. 6. The Working Plan has set apart an area for experimental thinnings beginning at 6 years. It seems to me that until their results are fully collected and studied no change in this important prescription of the plan would be justified.

6. For the purposes of this paper, and with a view to determine the comparative condition and rate of growth in the three plantations, the following measurements were made in July 1916 in the plantations of 1907-08 to 1910-11 :—

(i) The average girth of 100 trees in each year and each plantation was taken.

(ii) The average height of 5 well-grown trees of the average girth so obtained.

(iii) The number of trees found living in one acre of each plantation.

The results are shown below :—

Name of Plantation.	Age of Plantation.	Average girth at $4\frac{1}{2}'$.	Average height of trees of the average girth.	Number of stems per acre.
Kodibag ...	9	24″	93′	287
	8	20″	74·5′	290
	7	No plantation of	this age.	
	6	16″	67·5′	377
Chitakule ...	9	$22\frac{1}{2}$″	64·5′	245
	8	20″	59′	311
	7	17″	57′	424
	6	16″	57·5′	414
Arghe ...	9	No plantation of	this age.	
	8	$14\frac{1}{2}$″	50′	371
	7	14″	47′	420
	6	12″	41′	397

If we take the height and girth (reduced to sectional area) to be factors of the volume and put the productive quality of Kodibag at 1 or full, then the productive qualities of Chitakule and Arghe are respectively ·5 and ·3.

7. There is no doubt that the difference between these three plantations is chiefly due to soil. (In Arghe the effect is aggravated by unfavourable position as regards markets.) It is, however, held by some officers to be largely due to the fact that the thick covering of needles on the ground is not removed by the people in Chitakule and Arghe, as it is in Kodibag, with the result that the two former plantations have become surcharged with acid matter. It is very doubtful whether this makes more than a small difference. It does not account for the dying-off of numbers of plants in Arghe, in places where, so far, there is almost no accumulation of needles. The matter can only be determined by experiment, *i.e.*, by marking off certain areas in Arghe and Chitakule, removing the needle-cover regularly, and noting any difference in height and growth that may result. The experiment would be a little troublesome and expensive, but it is suggested that it might be carried out, and opinion is invited on the point.

8. *The rotation.*—This has been fixed at 30 years, as falling between the rotation of the greatest volume (33), and that at which the soil net rental was found to culminate (27). It has been suggested that, better financial results would, in practice, result if a low rotation of 10 years were fixed, and three crops of 10 years each were clear-felled within the time now taken over one. I am informed that this is done in some Casuarina plantations in Madras. It is certain that the size of the trees at 10 years is more suitable for fuel than at 30, owing to the greater ease with which they can be converted and handled. If 280 poles per acre (about the number usually found in 10-year-old woods) fetch an average of annas 12—*vide* result of thinnings—then a revenue of Rs. 210 at 10 years, or a total of Rs. 630 during 30 years, would result, which would be worth (by comparison with a similar revenue realized in a lump at 30 years) Rs. 980, allowing for compound interest at 4 per cent. On the face of it, this compares very favourably with the actual

revenue realized per acre, of Rs. 430 at 39 years in Kodibag. Against it would of course come a trebled cost of replanting, and the interim revenue from thinnings under a 30-year rotation. The matter appears of vital interest, and the Conservator has approved the experimental measure of felling an acre of 10-year-old wood and comparing the net revenue with that of an acre of old wood, both to be felled, converted and sold departmentally at the same time. The results will be duly reported at a future conference.

9. Now the price of planting an acre of wood in Arghe is Rs. 82 which, at 4 per cent. compound interest, is equal to Rs. 266 at 30 years, while the revenue per acre felled so far is Rs. 114, to which the value of thinnings will have to be added. Taking the value of the two thinnings at Rs. 25 and Rs. 50 in the 10th and 20th years respectively (Working Plan estimate), and capitalizing it, we find it works out to Rs. 129 at the end of the rotation. Thus the total revenue and expenditure, with the present prices for coupes on a rotation of 30 years, are Rs. 243 and Rs. 266 respectively showing that the plantation is being worked at a loss, and that there is no justification in keeping it up, unless a more paying rotation can be fixed upon.

NEW INDIAN SPECIES OF FOREST IMPORTANCE.

PART 3.

The object of the present list, which is appearing in instalments in the *Indian Forester*, is to facilitate the correct identification of specimens by constituting a complete record of all important Indian forest species which are not included either in Hooker's *Flora of British India* or in Brandis's *Indian Trees.*

From this list the following are omitted :—

(1) Species not definitely known to occur in the Indian area but which are reported from adjacent countries, *e.g.*, Ceylon, Malay Peninsula, Siam and Afghanistan.

(2) Exotic species cultivated in India but which have not become naturalized there.

(3) All species, the publication of which is invalid according to the Vienna Rules.

(4) A mere change of name for a specific group already described in the *F. B. I.* or *Indian Trees* under another name.

The date of first publication is given for each species new to science and for others a reference is given to the most recent or easily accessible literature.

Up to date this list includes 345 species as follows:—

In Part 1 (see *Ind. For.* 39, p. 413)	=	98
" " 2 (l. c. 40, p. 404)	=	108
" " 3, the present instalment	=	139
		345

LIST NO. 3.

Acacia columnaris, Craib, *Leguminosæ* (Kew Bull., 1915, p. 410), S. India.

A. Gageana, Craib, *Leguminosæ* (l. c., p. 409), U. P., Bengal, Assam.

A. Hoenackeri, Craib, *Leguminosæ* (l. c., p. 408), S. India.

A. insuavis, Lace, *Leguminosæ* (l. c., p. 401), Burma.

5. **A. macrocephala,** Lace, *Leguminosæ* (l. c., p. 401), Burma.

A. Myaingii, Lace, *Leguminosæ* (l. c., p. 114), Burma.

A. oxyphylla, Graham, *Leguminosæ* (l. c., p. 409), Assam.

A. torta, Craib, *Leguminosæ* (l. c., p. 410), Ind. Peninsula.

Acalypha Lacei, Hutchinson, *Euphorbiaceæ* (l. c., 1914, p. 381), Burma.

10. **Acronychia Barberi,** Gamble, *Rutaceæ* (l. c., 1915, p. 345), Madras.

Adina indivisa, Lace, *Rubiaceæ* (l. c., p. 115), Burma.

Aglaia Barberi, Gamble, *Meliaceæ* (l. c., p. 346), Madras.

• **A. Bourdillonii,** Gamble, *Meliaceæ* (l. c., p. 346), Travancore.

A. canarensis, Gamble, *Meliaceæ* (l. c., p. 347), Madras.

15. **A. Maiae,** Bourd., *Meliaceæ* (Journ. Bo. Nat. His. Soc., XII, 350), Travancore.

A. pedicellaris, C. DC., *Meliaceæ* (Mon. Phan. I, p. 607, 1878), Burma, Andamans.

Alangium alpinum, Smith and Cave, *Cornaceæ* (Rec. Bot. Sur. Ind., VI, 1914, p. 96), E. Himalaya.

Albizzia crassiramea, Lace, *Leguminosæ* (Kew Bull., 1915, p. 402), Burma.

Allospondias laxiflora, Lace, *Anacardiaceæ* (l. c., p. 397), Burma.

20. **Alseodaphne Keenanii,** Gamble, *Lauraceæ* (l. c., 1914, p. 188), Burma, Assam.

Amoora moulmeiniana, C. DC., *Meliaceæ* (Mon. Phan. I, p. 584, 1878), Burma.

Anaphalis Bournei, Fyson, *Compositæ* (Kew Bull., 1914 p. 209), S. India.

Anogeissus coronata, Stapf., *Combretaceæ* (l. c., p. 153) Rajputana, Merwara.

Ardisia gracilis, Lace, *Myrsinaceæ* (l. c., p. 153), Burma.

25. **Argyreia superbiens,** Cam., *Convolvulaceæ* (Rec. Bot. Sur. Ind., VI., p. 144, 1914), S. India.

Aristolochia piperifolia, Griff., *Aristolochiaceæ* (Itin Notes, p. 19, 1848), N. E. India.

Artabotrys uniflorus, Craib, *Anonaceæ* (Kew Bull., 1915 p. 435), Burma.

Asparagus monophyllus, Baker, *Liliaceæ* (Journ. Linn. Soc., 1875, p. 604), Baluchistan.

tylosia crassa, Prain, *Leguminosæ* (Journ. As. Soc Beng., 66, pp. 45, 432, 1898), India and Burma.

30. **Balanites triflora,** Van. Tiegh, *Simarubaceæ* (Kew Bull., 1913, p. 135), Burma.

Bassia butyraceoides, Scott, *Sapotaceæ* (Kew Bull., 1916, p. 36), Assam.

Bauhinia isopetala, Griff., *Leguminosæ* (Notul IV, p. 451, 1854), Burma.

B. sericea, Lace, *Leguminosæ* (Kew Bull., 1915, p. 400), Burma.

Berberis tinctoria, Lesch., *Berberidaceæ* (Gamble's Fl., Mad., p. 32), S. India.

35. **Bombax scopulorum,** Dunn, *Malvaceæ* (l. c., p. 100), Travancore.

Boswellia glabra, Roxb., *Burseraceæ* (l. c., p. 168), S. India.

Buchanania Barberi, Gamble, *Anacardiaceæ* (Kew Bull., 1916, p. 135), S. India.

Buettneria integrifolia, Lace, *Sterculiaceæ* (Kew Bull., 1915, p. 396), Burma.

Capparis Cleghornii, Dunn, *Capparidaceæ* (Gamble's Fl., Madras, p. 46), S. India.

40. **C. fusifera,** Dunn, *Capparidaceæ* (Kew Bull., 1914, p. 377), Madras.

C. tomentella, Dunn, *Capparidaceæ* (Gamble's Fl., Mad., p. 46), Travancore.

Cassia laevigata, Willd., *Leguminosæ* (Fyson's *Flora of Nilgiri*, p. 125, 1915), native of tropical America, naturalised in Garhwal, Sikkim, Nilgiris, Khasias and elsewhere.

Citrus ichangensis, Swingle, *Rutaceæ* (U. S. Dept. Agric. Journ. I (1913), pp. 1—14), Assam.

Clematis Bourdillonii, Dunn, *Ranunculaceæ* (Kew Bull., 1914, p. 181), Travancore.

45. C. **burmanica,** Lace, *Ranunculaceæ* (Kew Bull., 1915, p. 394), Burma.

C. **Craibiana,** Lace, *Ranunculaceæ* (l. c., p. 395), Burma.

C. **Munroana,** Wt., *Ranunculaceæ* (Gamble's Flora, Madras, p. 3, 1915), S. India.

C. **theobromina,** Dunn, *Ranunculaceæ* (Kew Bull., 1914, p. 181), Madras.

Cordia globifera, W. W. Smith, *Boraginaceæ* (Rec. Bot. Sur. Ind., VI, 1914, p. 102), Burma.

50. **Cyclea fissicalyx,** Dunn, *Menispermaceæ* (Gamble's Fl., Madras, p. 31), S. India.

Derris Lacei, Dunn, *Leguminosæ* (Kew Bull., 1914, p. 206), Burma.

Dioscorea Arachidna, Prain and Burkill, *Dioscoreaceæ* (Journ. As. Soc. Beng., X, 1914, p. 21), Assam.

D. **Brandisii,** Prain and Burkill (l. c., p. 27), Burma.

D. **Clarkei,** Prain and Burkill (l. c., p. 16), Naga Hills.

55. D. **Hemsleyi,** Prain and Burkill (l. c., IV (1908), p. 451), Shan States.

D. **Kalkapershadii,** Prain and Burkill (l. c., X, 1914, p. 24), Chota Nagpur and Madras.

D. **Lepcharum,** Prain and Burkill (l. c., p. 36), Bengal, Assam, Burma.

D. **membrancea,** Pierre (l. c., p. 13), Burma.

D. **Rogersii,** Prain and Burkill (l. c., p. 27), Andamans.

60. D. **tentaculigera,** Prain and Burkill (l. c., p. 15), Burma.

D. **trinervia,** Roxb. (l. c., p. 32), Assam.

D. **velutipes,** Prain and Burkill (l. c., p. 19), Shan States.

Diospyros Barberi, Ramaswami, *Ebenaceæ*, (l. c., p. 47), Tinnevelly.

D. glandulosa, Lace, *Ebenaceæ* (Kew Bull., 1915, p. 349), Burma.

65. **Dischidia Micholitzii,** N. E. Brown, *Asclepiadaceæ* (Kew Bull., 1913, p. 357), Burma.

Dunbaria gracilipes, Lace, *Leguminosæ* (l. c., 1914, p. 152), Burma.

Dysoxylum ficiforme, Gamble, *Meliaceæ* (Gamble's Fl., Madras, p. 178), Travancore.

Edgeworthia longipes, Lace, *Thymelæaceæ* (Kew Bull., 1914, p. 380), Burma.

Elæocarpus Stapfianus, Gagnepain, *Tiliaceæ* (Not. Sys. I (1909), p. 136), Assam.

70. **Eriolæna Lushingtonii,** Dunn, *Sterculiaceæ* (Kew Bull., 1915, p. 88), Madras.

Euonymus godaverensis, Haines, *Celastraceæ* (Indian For. (1914), p. 95), Chanda.

E. longipes, Lace, *Celastraceæ* (Kew Bull., 1915, p. 396), Burma.

Euphorbia caducifolia, Haines, *Euphorbiaceæ* (Ind. For. (1914), p. 154), Central Provinces.

Ficus cupulata, Haines, *Urticaceæ* (Kew Bull., 1914, p. 154), Central Provinces.

75. **Garcinia Imberti,** Bourd., *Guttiferæ* (Journ. Bo. Nat. His. Soc., XII, 349), S. India.

G. malabarica, Talbot, *Guttiferæ*, (l. c., XI, p. 234), S. India.

Glyptopetalum Lawsonii, Gamble, *Celastraceæ* (Kew Bull., 1916, p. 131), S. India.

Gomphandra coriacea, Wt., *Icacinaceæ* (Gamble's Fl., Mad., 195), S. India.

Goniothalamus rhynchantherus, Dunn, *Anonaceæ,* (Kew Bull., 1914, p. 182), Madras, Travancore.

80. **Gutzlaffia glandulosa,** Lace, *Acanthaceæ* (l. c., 1915, p. 406), Burma.

Hippocratea Bourdillonii, Gamble, *Celastraceæ* (l. c. 1916, p. 132), S. India.

Hypericum Wightianum, Wall., *Hypericaceæ* (Gamble's Fl., Mad., p. 70), S. India.

Ilex Englishii, Lace, *Ilicaceæ* (Kew Bull., 1914, p. 379), Burma.

Indigofera Houer, Forsk., *Leguminosæ* (Cooke Fl. Bo., I, 318, 1902), India and Burma.

85. **Ixora Meeboldii,** Craib, *Rubiaceæ* (Kew Bull., 1914, p. 29), Burma.

Lasianthus coffeoides, Fyson, *Rubiaceæ* (l. c., p. 185), Madras.

Lespedeza speciosa, Royle, *Leguminosæ* (Fedde Rep. Nov. Sp., p. 514), N.-W. India.

Lonicera Buchananii, Lace, *Caprifoliaceæ* (Kew Bull., 1915, p. 403), Burma.

Mahonia siamensis, Takeda, *Berberidaceæ* (l. c., p. 422), Burma.

90. **Marsdenia carnosa,** Lace, *Asclepiadaceæ* (l. c., p. 404), Burma.

Meliosma Mannii, Lace, *Sabiaceæ* (l. c., p. 113), Burma.

Microtropis Stocksii, Gamble, *Celastraceæ* (l. c., 1916, p. 132), S. India.

Millettia subpalmata, Dunn, *Leguminosæ* (l. c., 1914, p. 207), Burma.

M. utilis, Dunn, *Leguminosæ* (l. c., p. 207), Burma.

95. **Mucuna Collettii,** Lace, *Leguminosæ* (Kew Bull., 1915, p. 398), Burma.

Mycetia (-Adenosacme, Gen. Pl. and F. B. I.) **glandulosa,** Craib, *Rubiaceæ* (Kew Bull., 1914, p. 125), Burma.

Mycetia Parishii, Craib, *Rubiaceæ* (l. c., p. 28), Burma.

Ochna Beddomei, Gamble, *Ochnaceæ* (l. c., 1916, p. 34), S. India.

O. Heyneana, W. and A., *Ochnaceæ* (Gamble's Fl., Madras, p. 166), S. India.

100. **Olea Bournei,** Fyson, *Oleaceæ* (Kew Bull., 1914, p. 186), Madras.

Orophea monosperma, Craib, *Anonaceæ*, (Kew Bull., 1915, p. 434), Andamans.

Oxyspora rupicola, Lace, *Melastomaceæ* (l. c., p. 402), Burma.

Pentasacme shanense, MacGregor and Smith, *Asclepiadaceæ* (Rec. Bot. Sur. Ind., VI, 1914, p. 101), Burma.

Peperomia cochinensis, C. DC., *Piperaceæ* (Fedde Rep. Nov. Sp. XIII, p. 297, 1914), Cochin.

105. **P. Meeboldii,** C. DC. (l. c., p. 297 (1914)), India.

Piper nigramentum, C. DC. (l. c., p. 299 (1914)), Sikkim.

Piper pykarahense, C. DC. (l. c., p. 300 (1914)), Nilgiris.

P. sonadense, C. DC. *Piperaceæ* (l. c., p. 298 (1914)), Sikkim.

Prosopis juliflora, DC., *Leguminosæ* (Ind. For. Rec., IV, 3, 1913), native of tropical America, naturalised in Sind and Punjab.

110. **Pueraria Lacei,** Craib, *Leguminosæ* (Kew Bull., 1915, p. 399), Burma.

Pyrus kachinensis, W. W. Smith, *Rosaceæ* (Rec. Bot. Sur. Ind., VI, 1914, p. 100), Burma.

Rhododendron burmanicum, Hutchinson, *Ericaceæ* (Kew Bull., 1914, p. 185), Burma.

R. carneum, Hutchinson, *Ericaceæ* (Curtis's Bot. Mag., t. 8634), Burma.

Rhus amherstensis, W. W. Smith, *Anacardiaceæ* (Rec. Bot. Sur. Ind., VI, 1914, p. 99), Burma.

115. **Sageraea (-Bocagea,** F. B. I.) **grandiflora,** Dunn, *Anonaceæ* (Kew Bull., 1914, p. 182), Travancore.

Salacia Beddomei, Gamble, *Celastraceæ* (Kew Bull., 1916, p. 133), S. India.

S. malabarica, Gamble, *Celastraceæ* (l. c., p. 133), S. India.

S. Talbotii, Gamble, *Celastraceæ* (l. c., p. 133), Bombay.

Sansevieria burmanica, N. E. Brown, *Liliaceæ* (Kew Bull., 1915, p. 228), Burma.

120. **S. lanuginosa,** Wild, *Liliaceæ* (l. c., p. 225), Malabar.

Sarcococca Wallichii, Stapf., *Buxaceæ* (l. c., 1916, p. 37), Nepal.

Senecio calcadensis, Ramaswami, *Compositæ* (Rec. Bot. Sur. Ind., VI, p. 138, 1914), S. India.

Strobilanthes membranaceus, Talbot, *Acanthaceæ* (List ed. 2 (1902), p. 261)), Bombay.

S. minor, Talbot, *Acanthaceæ* (Cooke Fl. Bo., II, 372, 1905), Bombay.

125. **S. mogokensis,** Lace, *Acanthaceæ* (Kew Bull., 1915, p. 406), Burma.

S. reticulatus, Stapf *Acanthaceæ* (Kew Bull., 1894, p. 347), Bombay.

Strombosia leprosa Talbot, *Olacaceæ* (Journ. Bo. Nat. His. Soc., XI, 235, Fst. Fl., I, 260), Bombay.

Thunbergia maculata, Lace, *Acanthaceæ* (Kew Bull., 1914, p. 154), Burma.

T. papilionacea, W. W. Smith, *Acanthaceæ* (Rec. Bot. Sur. Ind., VI, 1914, p. 103), Burma.

130. **Trachycarpus Takil,** Becc, *Palmæ* (Journ. Bo. Nat. His. Soc., XX, p. 981), W. Himalaya.

Turpinia malabarica, Gamble, *Sapindaceæ* (Kew Bull., 1916, p. 135), S. India.

Unona Ramarowii, Dunn, *Anonaceæ* (l. c., 1914, p. 183), Madras, Travancore.

Uraria barbata, Lace, *Leguminosæ* (Kew Bull., 1915, p. 397), Burma.

Uvaria eucincta, Bedd., ex Dunn, *Anonaceæ* (Kew Bull., 1914, p. 182), Madras.

135. **Ventilago Goughii,** Gamble, *Rhamnaceæ* (Kew Bull., 1916, p. 134), S. India.

V. lanceolata, Gamble, *Rhamnaceæ* (l. c., p. 134), S. India

Vernonia Bourneana, W. W. Smith, *Compositæ* (Rec. Bot. Sur. Ind., VI, 1914, p. 101), S. India.

V. Ornata, Talbot, *Compositæ* (Journ. Bo. Nat. His. Soc. XI, p. 691, Fst. Fl., II, 137, 1911), Bombay.

139. **V. Ramaswamii,** Hutchinson, (Kew Bull., 1916, p. 35), Madras.

R. S. HOLE,

Forest Botanist.

ATHLETICS AT THE FOREST RESEARCH INSTITUTE AND COLLEGE, DEHRA DUN.

(Contributed.)

As it is now the end of the College year, the following notes on the athletics of the past year may prove of interest to both out-going and in-coming students.

The Sports Committee met in June 1916 and the following resolutions were passed :—

1. That the days specially allotted for each game be—

Mondays and Tuesdays ...	...	Hockey.
Wednesdays and Thursdays	...	Football.
Fridays and Saturdays ...	...	Cricket.

2. That the subscription be Rs. 5 for the season.

3. That annas 8 be the entrance fee for each event at the Sports.

4. That the Club do not provide tennis balls but only the nets and the courts.

Each of the Instructors undertook to look after a particular game—Mr. Kirwan, cricket ; Mr. Hamilton, football ; Mr. Wimbush, tennis ; and Mr. Wood, hockey.

The *Cricket* team has had quite a successful season, and has won all matches. This is due, however, more to the weakness of our opponents than to the strength of the College Team. In fact, in every branch this year, our successes have been mainly due to our opponents' teams being much weaker than usual, owing to the war. The lack of a ground exclusively for cricket is a great handicap, and the present ground can only be used on non-polo days, the result being that the cricket team do not get nearly sufficient practice. The funds do not permit of the best materials being bought, especially bats, and this again is a handicap, but every year twice as much is spent on cricket as on any other game, and as comparatively few students play cricket more money cannot be given. The success of the team is mainly due to Mr. Kirwan, who was ably supported by Mr. Wimbush and Mr. Wood.

Football is the most popular game in the College, no fewer than ninety of the students played this year. The College Team

did moderately well, but could have done better. All matches were won except against the Gurkha Officers, who beat the College Team by three goals to nothing. The individual members of the team were quite as good as we have ever had at the College, but they never really got together ; this was due to the Captain being very slack and taking no interest in the team.

Hockey, on the other hand, was fortunate in having a very keen and energetic Captain in McDonald. Out of quite moderate material, he turned out a good team, and when the team went to Mussoorie for the tournament they did very well. In this tournament, we are usually badly knocked out in the first round. This year, in the first round, we beat St. Fidelis by five goals to two. In this match, two of our players were badly hurt, and could not play next day against the Survey team, by whom we were beaten, after a very hard fight, by two goals to one.

Tennis, although it is not considered a major game, is taken up by most of the students. This year a few matches have been played, not only against outside clubs, but also against the Staff. At the end of the season, a tournament was held, in which Maung Nee and Smith won the doubles and Khot won the singles, Khanna being runner-up.

The sports were a great success ; some of the times being very good, considering the state of the ground. McDonald easily won the Championship cup with twenty-six points, and his performances showed all-round excellence. The following is a list of the winners of each event :—

Championship Cup	...	McDonald 26 points.
Marathon Race	...	1st McDonald (42 min. 35 secs.)
		2nd Smith.
		3rd Bashir Ahmad.
		4th Jagat Singh.
One Mile ...	...	1st Aziz Khan (5 min. 17 secs.)
		2nd McDonald.
		3rd M. Hafiz.
Half Mile ...	...	1st Jagat Singh (2 min. 21 secs.)
		2nd Aziz Khan.
		3rd Rup Kishen.

Quarter Mile ...	...	1st McDonald (58$\frac{2}{5}$ secs.)
		2nd Gandurb Singh.
		3rd Smith.
100 Yards ...	...	1st McDonald (10$\frac{4}{5}$ secs.)
		2nd Hobday.
		3rd Smith.
Hurdles ...	...	1st McDonald (19 secs.)
		2nd Hilbert.
		3rd Smith.
High Jump ...	...	1st A. Sanyal (5′ 1″).
		2nd Hobday (4′ 11″).
Long Jump ...	...	1st Hobday (17′ 5$\frac{1}{2}$″).
		2nd McDonald (17′).
Obstacle Race ...	...	1st Joardar.
		2nd M. Hafiz.
		3rd Jagat Singh.
Cricket Ball ...	...	1st Khot (87 yards).
Putting the Shot	...	1st Hobday (22′ 11″).
Sack Scrimmage	...	1st Jagdish Chandra.
		Atma Singh.
		Patel.
		Durga Das.
		2nd Lachman Singh.
		J. K. Pande.
		Aziz Khan.
		Rup Kishen.
Consolation Race	...	Mahomad Hussain.

The good times in this year's sports are entirely due to Mr. Wood, who spent a great deal of time in coaching the students, and the winners owe him a debt of gratitude.

AN ACCOUNT OF THE PRIZE-DAY AND ATHLETIC SPORTS AT THE BURMA FOREST SCHOOL.

BY C. G. E. DAWKINS, I.F.S.

The annual distribution of prizes, medals and certificates took place at Pyinmana on the 10th November. The occasion was a notable one, as marking the end of the old system under which the School year ended in November, but was rendered more notable by the presence of His Honour the Lieutenant-Governor and his staff, and a much more numerous concourse of visitors than usual.

His Honour, accompanied by Mr. W. J. Keith, Revenue Secretary, and his staff arrived by train at 3-15 P.M., and at once motored up to the School, where they were received at the main porch by Mr. C. G. Rogers, Chief Conservator of Forests, who introduced Mr. H. Carter and Mr. R. C. Milward, Conservators of Forests, the Examiners and Staff of the School and other officers of Pyinmana Forest Division. The party then moved into the Main Hall, where the proceedings were at once opened by the Chief Conservator with the following remarks:—

Speech by Mr. C. G. Rogers, Chief Conservator of Forests, Burma.

YOUR HONOUR, MR. CLIFFORD, LADIES AND GENTLEMEN, STUDENTS OF THE BURMA FOREST SCHOOL,

"Before asking the Director of the Burma Forest School to read a brief report on the work of the School during the past year, I must, on behalf of the Forest Department in Burma and myself, tell you how very keenly we appreciate the honour you have conferred upon us by finding time to come to Pyinmana and distribute certificates and prizes to the successful students of the Burma Forest School.

"I make no apology for asking you to come and see for yourself the good work which is being carried on at this Institution, because of the paramount importance of Forestry in Burma; the great interest you have long taken in education, and the enthusiasm with which you have identified yourself with everything which tends to develop this great, but at present little developed, Province is known to every one.

"It may interest you to know, Sir, that in 1914 no less than 62·9 per cent. of the Province consisted either of reserved or unclassed forests, as compared with 22·7 per cent. for the whole of the Indian Empire, and that the annual gross revenue for the same year was more than 114 lakhs of rupees, a little more than one-third (34·3 per cent.) of the total Forest Revenues of the entire Indian Empire. The figures for 1913-14 are taken as they are not affected by the War.

"The Burma Forest School was started in 1898 at Tharrawaddy, when a simple course of instruction was given in Burmese by Provincial Service Officers, under the general supervision of the Divisional Forest Officer.

"It soon became apparent that, if the forests of the Provinces were to be efficiently managed, the scope of the School must be enlarged, that the simple course in Burmese must become supplementary to a more advanced course of instruction in English and that the courses of instruction must be largely given by the most capable practical Forest Officers in the Province under the control of an Imperial Service Officer. Advantage was taken of the change, in the nature of the instruction, to move the School from Tharrawaddy to Pyinmana, on account of its more central situation and its better climate.

"The present buildings were completed in 1910, and the School was moved from Tharrawaddy in that year, the course of instruction in English being started the following year.

"At present, students passing out of the School, either belong to, or will join, the Subordinate Forest Service either as Rangers or Deputy Rangers. They are essentially executive and protective officers and have to directly carry out works for the improvement or exploitation of the forests.

"Under the existing rules, it is not possible for Rangers who have passed through the Burma Forest School to be promoted to the Provincial Forest Service except for long and meritorious service. That this is a mistake has been clearly recognized at the meeting of the Board of Forestry—a body consisting of Chief Conservators, Conservators of Provinces where there is no Chief

Conservator, presided over by the Inspector-General of Forests—at their meeting held last March, and it is to be hoped that, in the near future, the Provincial Forest Service will be open to passed students of this School, who have served for 10 years, and have proved themselves capable Forest Officers.

"The necessity for having trained subordinates is becoming felt more and more, and in view of the small number of subordinates, who can be trained in Burma annually (10 in the upper course and 20 in the lower course), it is probable that, at no very distant date, it will be found necessary to have more than one forest school.

"With your permission, I should like to address a few words to the out-going students :—

"Senior Students.—You have now completed a two years, course of instruction at the School.

"What I want to impress upon you most is—

(1) that you are now in a better position to begin to learn your profession than you were when you joined this institution ;

(2) that years of learning, the practice of what you have been taught the theory here, will be necessary before you can hope to consider yourselves really efficient Forest Officers ;

(3) that you will go on learning so long as you are in the Department.

"You have a great deal to learn and the student who realizes this most fully, and who goes on learning from his more experienced superior officers, is the man who will have the most successful career in the Forest Department.

"I cannot conclude without expressing my indebtedness to Mr. Clifford and his staff for all the good work they have done at the School. Mr. Clifford entered upon his duties with a determination to make the School an unqualified success, and the high standard reached by the students under his direction and instruction is the best proof of the success which has attended his efforts. The Province, as a whole, is greatly indebted to Mr. Clifford, for the way in which he has made the course of instruction, one in which the

greatest importance is laid upon the practical application of the principles taught in the class room. This is what it should be, and what, I hope, it always will remain."

The Director, Mr. J. D. Clifford, then read his Report as follows:—

Speech by Mr. Clifford, Director, Burma Forest School, Pyinmana.

YOUR HONOUR, MR. ROGERS, LADIES AND GENTLEMEN,

"It is my pleasant duty to welcome to-day, on behalf of the Burma Forest School, a Lieutenant-Governor whose influence on education has been so great.

"Your Honour is doubtless aware that this institution is not a school in the usually accepted sense of the word. The students are all of them paid Government servants, or students to whom stipends have been given by Government, to help to defray the cost of attending the school, and who will be appointed to the Subordinate Forest Service, if successful in gaining a certificate at the end of the course. No less than seven months of each year are spent on practical work in the forests. Two courses of instruction are carried on side by side: the one, an Upper Course in English; and the other, a Lower Course in the Vernacular. Both extend over a period of two years, at the end of which, students gaining the Higher Certificate are eligible for Forest Rangerships, and those gaining the Lower Certificate, for Deputy Rangerships, in the Subordinate Forest Service. The door to the Provincial Forest Service is not barred however, and I believe many of the passed students, after necessary experience and proof of ability, will ultimately become efficient members of that service.

"Of the students passing out to-day, nine have obtained the Higher Certificate, two obtaining Honours; and sixteen have obtained the Lower Certificate, three passing with Honours.

"A brief outline of the work these students have done may not be out of place:

"The open season of 1915 was spent in the forest where practical instruction in boundary-blazing, climber-cutting, road alignment, thinnings, girdling and improvement felling was carried out. In the following rains term, the principles, on which the

Science of Forestry is based, were taught, with a break of five weeks in the middle, during which a rains tour of practical training was undertaken.

"The second open season, starting on December 1st last year, was occupied in practical forest work, carried out by the students independently, under supervision of the staff, in important engineering work including the complete building of a 40-ft. span N-truss bridge and in a field survey.

"Lectures in the following rains term were largely devoted to revision of Forestry, Engineering, Surveying, Botany and other subjects taught on tour, and the term was again broken by another five weeks' rains tour, during which the Chief Conservator inspected the actual works being carried out by the students.

"The value of these rains tours can scarcely be exaggerated, the old idea of not touring in the rains being totally unsuited for the extensive teak forests of this province.

"This is the last occasion on which the annual prize-day will be at this time of the year. In order to allow of Government subordinates being sent to the school at the end, instead of the beginning, of the working season, and also to admit of a longer period of training in the forests, the school year has been re-adjusted, and will, from 1918 onwards, commence on the 15th May, and end in the following April. Both students and examiners will no doubt find final examinations in the hot weather very trying, but such examinations will come at the end of the practical course, and other advantages of the new régime outweigh all foreseen disadvantages.

"For the four years since the establishment of the English course, steady progress has been maintained, but we still suffer from lack of funds, for minor extensions, and improvements of the existing school buildings.

"The great war, the satisfactory end of which we all hope is now looming within sight, is the cause of these works being postponed, though administrative sanction has been long accorded. A laboratory and a dark-room are urgently needed, though perhaps the students might consider the reclaiming of their football and recreation grounds as of even more importance,

"Twenty-six senior students attended a course of instruction in the principles of First Aid and Bandaging given by Sub-Assistant Surgeon Mg. Po Wain, and 16 were successful in obtaining certificates. In future years, when a Sub-Assistant Surgeon is permanently attached to the school, this instruction will be included in the syllabus, and extended so as to impart a useful knowledge in hygiene and sanitation.

"Athletics at this school do not receive the attention they deserve, entirely due, I am afraid, to apathy on the part of the students themselves. The football team, though containing several good individual players, did not do well, mainly because of lack of keenness in practice games. A most satisfactory feature, however, was that the team set a good example in always playing a clean and sporting game.

"I will now ask Your Honour to distribute the medals and certificates which have been won by the students."

After a Burmese translation had been read, the Director then gave out the names of the out-going students to whom prizes and certificates had been awarded, and the presentations were made personally by His Honour.

After the distributions, His Honour the Lieutenant-Governor made the following speech :—

MR. ROGERS, MR. CLIFFORD AND GENTLEMEN,

"My presence here to-day bears witness to my interest in education generally, and in education in forestry in particular. I value this institution not only because it gives a good practical useful education, but also because the future development of the province depends in large measure on the success with which our forests are developed. Burma is the largest province in India. The area of the forests already under reservation in Burma is nearly half as much again as that of any other province in India, and exceeds one-fourth of the total area of reserved forests in the whole Indian Empire. This area, large though it is, is less than one-fifth of the total forest area in the province, much of which still awaits examination with a view to reservation. The forest revenue in normal years exceeds one crore of rupees, or

more than one-third of the total forest revenue in India, and contributes a fifth of the total receipts of the provincial Budget. Burma has a practical monopoly of teak, one of the most valuable woods in the world, and contains many other valuable timbers of which the exploitation is still in its infancy.

"For development of the revenues of forests, an efficient staff of subordinates is essential, and this school is the only institution at present in the province which trains subordinate staff. Mr. Rogers has referred to a recent recommendation of the Board of Forestry that better prospects of promotion to the Provincial Forest Service should be held out to Rangers. The Board recommended that a maximum of one-third of the appointments in the Provincial Forest Service should be filled by Rangers who have completed at least ten years of exceptionally meritorious service. This proposal has not yet been referred to the Government of Burma, and I do not wish to commit myself to any statement of policy at this stage. I am one of those who hopes that there will be a Forest Faculty in the future University of Burma. Meanwhile I can certainly say that the proposal of the Board of Forestry will be sympathetically considered by this Government.

"I wish to endorse all that Mr. Rogers has said to the out-going students. The only way to learn a thing is to do it yourself and to do it often. Keep up your study when you are getting your practical experience. It will make your work fresher and more alive. I want you particularly to remember that the work of a Forest subordinate requires the exercise of much tact, and I trust that you will strive to give effect to the policy of Government, and carry out the orders of your superior officers with the least possible friction to the villagers and other people with whom you come in contact. The restrictions necessarily imposed by the Forest law on the free issue of forest produce are undoubtedly irksome to people who do not fully understand the objects for which they are imposed. You should lose no opportunity of explaining to the villagers, with whom you come in contact, the objects which Government has in view in undertaking the conservation and the exploitation of forests. These objects are, first

to prevent the unnecessary waste of timber and other forest produce, and thereby to ensure that future generations shall not suffer by lack of thought on the part of the present generation; and, secondly, to provide the funds necessary to administer the country and provide it with the means of material and moral progress.

"I hope that the change in the School year from 1916 onwards will prove a success and that you now have got a settled course of study. A good many changes in curricula and syllabuses have been made in the past, and I hope that you have now secured a measure of stability.

"I cannot at present promise you money for the additions and improvements which are required for school buildings; but I will take note of your requirements and, on the earliest opportunity, see to what extent they can be granted.

"I am much gratified to see that 26 of the senior students attended a course of instruction in the principles of first-aid and bandaging, and I thoroughly approve of the proposal to include instruction in this subject and in hygiene, as a regular part of the training, in future years.

"I hope that all students will realise the importance of athletics and physical training. Hitherto there has been some shortcoming in this respect. I am glad to mention that the Hon'ble Mr. J. E. DuBern (whose presence to-day we specially welcome) has generously endowed a Gold Medal to be granted annually to the best all-round athlete in the school. He has also given a Special Prize. I trust that Mr. DuBern's generosity may bear fruit in greater physical fitness among the students.

"And I should like to offer my congratulations to the distinguished student who has not only won the Gold Medal for athletics, but has swept the board in prizes for intellectual attainments, Maung Kantaya.

"In conclusion, I have only to congratulate Mr. Clifford and the staff, on the results which you have already achieved, and to wish the school all prosperity."

A Burmese translation of His Honour's speech was then read by Maung Tha Myaing, A. T. M., Vernacular Instructor at the School.

A special reference must be made to the Main Hall of the School, which was filled to overflowing with guests, including numerous ladies, and had been decorated for this very 'special' occasion with great care and taste by the Vernacular Instructor, Mg. Tha Myaing, and the students of the School. The floral adornment of the windows were particularly noticeable for their artistic realism.

After tea and refreshments had been served to the party, and the annual group photograph of the School had been taken, His Honour and Staff were conducted by the Director over the main School Buildings, where several examples of practical work by the students were set out for inspection. The students' quarters were next visited, and the party then passed through the School Recreation Ground to the Nursery, which is approached by a suspension bridge built entirely by the Students two years ago. His Honour showed great interest in all he saw, and it is certain that, in so kindly visiting the Forest School, he has conferred a lasting benefit on the welfare of Forestry in the Province.

His Honour and his Staff then entered their cars and after three hearty cheers had been given for the Lieutenant-Governor left for the station.

The Annual Athletic Sports and At Home on the School Recreation Ground were held this year on the 11th November, the day following the Prize Distribution.

The Sports were, as on past occasions, exceedingly well organized by Mr. A. J. Butterwick, Instructor at the School, to whom the greatest credit is due, not only for the arrangements made for the final day's sports, but for the trouble he has always taken in interesting the students in the various competitions and encouraging athletics in general. A great improvement is noticeable this year in the Recreation Ground itself, which is now a full-sized football ground, and will soon be further improved by the reclamation of its northern end, which is apt still to be swampy after heavy rain.

Preliminary heats of the Hurdles and 100 yards had been run off two days before. The events of the final day were as follows :—

100 yards	Winner—	Willix. Time 11 secs.
High Jump	„	Napoleon. Height 5 ft. 1¾ in.
120 yards' Hurdle Race ...	„	Mg. Shwe Thwe. Time 19 secs.
Long Jump	„	Mg. Kin. Length 18 ft. 6 in.
Kicking the football through a 4-feet square.	„	Mg. Ba Than.
Three-legged Race ...	„	Mg. Kantaya and Mg. Gywet.
One-Mile Race	„	Mg. Kantaya.
Sack Scrimmage	„	Willix's team.
Victoria Cross Race ...	„	Mg. Mya Gyi and Mg. Tun Mg.
Obstacle Race	„	Mg. Po Ni.
Tug-of-War (Juniors *v.* Seniors.)	„	Seniors.

In addition, there were handicap races for small children, which caused much amusement. Throughout the afternoon, students Mg. Ba Tun and Mg. Maung kept the crowd amused by their antics as clowns.

On the final day, the standard of excellence in the first four events—the 100 yards in 11 secs., the high jump 5′ 1¾″, the broad jump 18′ 6″, and the hurdles 19 secs.—was really quite good, considering the short time available for students to practise. The mile was slow, but the winner was never pressed and won by more than half a lap.

The School Staff were At Home on the ground, and a spacious and well supplied tea tent was ably presided over by Miss Clifford, sister of the Director of the School. Numbers of guests were present, all of whom found time to partake of refreshments, in spite of the keen interest they took in the sports. Several of the more

juvenile of the guests, it is feared, almost confined their interest to the former, but are, it is believed, none the worse.

Every one of course regretted that His Honour the Lieutenant-Governor had been unable to extend his stay for another day, but his visit of the previous afternoon was entirely responsible for the much larger number of guests and visitors present than on former occasions.

Mrs. Carter, wife of the Conservator of Forests, Southern Circle, very kindly consented to give away the prizes to the lucky athletes—some of these, having taken part in a diabolically conceived obstacle race, were indeed in a lamentable condition!—and after there cheers had been given first for Mrs. Carter, and next for popular Examiners, the party dispersed—the majority homewards, but an unmistakable drift back towards the refreshment tent was also noticed.

The same evening a "pwe" was held at the school, at which a vast crowd of people from Pyinmana spent the night; moreover, the constantly recurring whir of motor-cars up and down the School drive bore witness to the popularity of the performance with the Director and his guests.

NEW YEAR'S HONOURS LIST.

We congratulate Mr. Nil Kanta Mukherji, Extra-Deputy Conservator of Forests, Sylhet, Assam, on being awarded the title of *Rai Sahib*: and Forest Ranger Maung Kyaw Zan of Burma the title of *Ahmudan gaung Tazeik ya Min*, on the occasion of the last Honours List.

EXTRACTS.

OILED PAPER.

Oiled paper has been found to be an excellent material for packing tree seedlings, when shipped in crates. When crates are not used, paper-lined burlap makes a particularly satisfactory wrapper.—[*Scientific American.*]

WOOD FLOUR AND THE MANUFACTURE OF DYNAMITE AND LINOLEUM.

More than 20,000 tons of wood flour, valued at $300,000, are used annually in the United States in two widely different industries: the manufacture of dynamite and the manufacture of inlaid linoleum.

Wood flour is also used in making composition flooring oatmeal paper, and in several other industries. It forms one of the means by which the huge waste product of our lumber mills is beginning to find some better means of disposal than the burner. Since a total of 36,000,000 cords of such waste is produced each year at saw-mills in the United States, of which about one-half goes into the furnaces as fuel, while the rest is burned as refuse to get rid of it, there is no lack of raw material for industries which can develop ways of turning this waste product to account.

All wood flour-using industries require a white or very light cream-coloured flour having good absorptive powers. The wood species that may be used are confined to the light, non-resinous conifers, and the white, broad-leafed woods like poplar. Spruce, white pine and poplar are the species most used. Mill waste, free from bark, furnishes much of the raw material for making wood flour.

For use in dynamite, the trade demands are said to require a white wood flour, since the freshness of dynamite stock is indicated by a light colour. Dynamite flour must also be very absorptive, so there will be no leakage of nitroglycerine from the finished product. Wheat flour mill refuse and infusorial earth have also been used in dynamite making, but wood flour has practically replaced them in this country.

In the manufacture of linoleum, either wood or cork flour is used. The flour is mixed with a cementing material, spread out on burlap and rolled or pressed to a uniform thickness. The cement is the expensive constituent. Cork linoleum is the cheaper because less cement is necessary. The patterns are printed on, leaving a dark base. For inlaid or straight-line linoleum, wood flour is used exclusively. Cork linoleum is always dark, and slightly more

elastic than that produced from wood flour. The wearing qualities are about the same.

Two methods of producing wood flour are practised: one, using millstones; the other, steel burr rollers to pulverize the wood. The latter requires only one-fourth as much power to operate as the former, and was developed on the Pacific coast to handle saw-dust as a raw material. The mills of Norway, which produce much of the European wood flour, are of the stone type.

Wood flour mills are scattered over the country from Maine to California, wherever the proper combination of wood and water power is available, and the domestic wood flour competes with the Norwegian product which, before the European war, was delivered at Atlantic ports for \$12·50 to \$15 per ton.

LANDOWNERS AND AFFORESTATION.

IMPORTANT DISCUSSION BY THE ENGLISH ARBORICULTURAL SOCIETY.

The 35th annual general meeting of the Royal English Arboricultural Society was held at the offices of the Royal Agricultural Society in Bedford Square, London, on Tuesday, when Lord Barnard (the President) was in the chair, and there was a large and influential gathering of landowners and others interested in timber growing.

The Council reported that they had had under consideration the present position and future developments of forestry in England and Wales, and ventured to submit, among others, the following resolutions for the consideration of His Majesty's Government:—

(1) That the war has shown a large increase in our wooded area to be vitally necessary in the national interests.

(2) That the creation of a strong separate Authority, responsible to Parliament, is an essential step to the extension and improvement of forestry.

(3) That such Authority should at once institute a survey of the country, and the land more suitable for silviculture than for

other purposes should be scheduled for afforestation, and that the work of afforestation should begin, largely through the agency of demobilized soldiers and sailors, as soon as the survey has disclosed a suitable area.

(4) That no curtailment of existing woodlands, private or public, shall be permitted without the consent of the Authority, and the replanting be done as soon as possible and opportunity of appeal be allowed to the Quarter Sessions of the county.

(5) That in the event of a private estate containing land which has been scheduled as suitable for afforestation, the owner should be called upon so to treat it, either (*a*) from his private resources, or (*b*) by means of a Government loan, with deferred interest and sinking fund. As an alternative, at the option of the owner, the State shall be required to lease or purchase such areas, paying in the former case a definite rental, with or without a share of the returns, to the owner. In case of dispute, the matter to be referred to Quarter Sessions.

(6) That while substantial results may be anticipated from improved methods and extended operations on private estates, national requirements in respect of timber will only be met by a large scheme of afforestation of mountain and heath land. Such land, previously surveyed and scheduled, should be acquired by the State by purchase, and if necessary with the exercise of compulsory powers.

Dr. Somerville proposed the adoption of the resolutions, and the motion was seconded by Sir Hugh Beevor, Bart., who observed that this country was not self-sufficing in forestry. He understood that the present outlook was that within three years there would be no pine woods practically in Great Britain—they would all be down. He admitted that the scheme now submitted was a radical one.

An animated debate ensued, and the proposals in various details were strongly criticized by a number of those present. One speaker declared that only seven members of the Council were present when the resolutions were passed by a majority.

Lord Barnard said that although there was a great deal in the principles underlying the resolutions and a great deal with which he honestly agreed, and upon which he felt very strongly, there was also a certain amount of principle underlying them which, he thought, was wholly mistaken and arrived at from too hasty a survey of the situation. He read letters from the Duke of Northumberland and the Earl of Powis, the latter of whom stated that he thought the owner should be encouraged, not forced, and that the Government should make their terms sufficiently attractive to induce owners to plant. Lord Barnard went on to say that he took it that the object of the movers of the resolutions was to promote the increased commercial growth of timber in this country, but he seriously doubted, supposing every one of the resolutions was carried out in its entirety, if they would have that effect.

In the result, the motion for the adoption of the resolutions was defeated, an amendment being carried by 32 votes to 10 to the following effect:—" That although largely in agreement with these recommendations, this meeting is of opinion that the report should be referred back to the Council for their further consideration and the preparation of a statement to be put before the Government after submission to a general meeting of the Society."—[*The Timber Trades Journal.*]

TEAK IN TRINIDAD.

(Proceedings of the Agricultural Society of Trinidad and Tobago, Vol. XVI, Part 9, September 1916.)

The following note on the growth of teak in Trinidad has been received at Kew from Mr. C. S. Rogers, Forest Officer, Trinidad and Tobago, with some interesting photographs, showing the remarkable size of the leaves and the vigour of the young trees:—

East Indian Teak, *Tectona grandis*, was first introduced into the plantations in the Forest Reserves in Trinidad in 1913. The seeds were obtained from Tharrawaddy, Burma, through the courtesy of

the Conservator of Forests, Pegu Circle. In 1913 about 14½ acres were planted, 2½ acres being situated in the Southern Watershed Reserve, about 7 acres in Arima Reserve, and 5 acres in the Central Range Reserves. In each locality the original forest containing no marketable timber of any consequence was felled, burnt, and lined out with stakes or pickets at 10 feet by 10 feet.

So far the best results have been obtained in the Central Range Reserve Plantation where 5 acres were planted 10 feet by 10 feet. Of the 2,178 pickets thirty-five were on unplantable ground, the remaining 2,143 were sown with teak seeds in July. The sowing was rather late owing to the impractability of getting the area ready at an earlier date. In the following January (1914) 1,339 pickets at which seeds had not yet germinated were resown.

At the end of March 1914, 1,758 teak seedlings had resulted and some of them were 6 to 10 feet high. In the following wet season the blank pickets were again sown. At the end of March 1915 when stock was taken it was found that there were only 12 blanks.

Some of the plants had attained a height of 23 feet and leaves were measured up to 36 inches in length by 25 inches in width, the teak being then between 20 to 21 months old from the date of sowing the seeds.

In October 1915 a tree was measured and found to be 32 feet high with a girth of 2 feet at ground-level and 16¼ inches at 3 feet and 14½ inches at 5 feet from the ground. Its age was 2 years and 3½ months from date of sowing.

The soil is a sandy loam of Tertiary origin. The elevation does not exceed 1,000 feet. The original forest contained some trees of large size, but the more valuable species had been cut out, and the remainder were for the most part unsaleable owing to distance from a market.

The normal rainfall for the district is about 115 inches but during the last two years it has been 20 per cent. below the average.

TREATMENT FOR ELECTRIC SHOCK.

The effect of striking the soles of the feet of a man rendered unconscious by an electric shock has been proved to be exceedingly effective by Mr. W. P. Stuckland, General Proprietor of the New York and Queen's Electric Light and Power Co. of New York City, who has for the past year been teaching his men to adopt this treatment. Mr. Stuckland quotes three cases in which the treatment has proved quite successful, apparently the soles of the feet should be struck violently, without removing the boots, with any small implement that may be handy, a pair of pliers or a small hammer, for example ; at the same time the tongue should be withdrawn as in the ordinary treatment of artificial respiration.—[*Indian Engineering.*]

VOLUME XLIII NUMBER 4

INDIAN FORESTER

APRIL, 1917.

POSSIBILITIES OF DEVELOPMENT IN THE HIMALAYAN CONIFEROUS FORESTS.

BY E. A. SMYTHIES, I.F.S.

"Out of the great coniferous wood districts of the ancient world, there remains but the Indian district on the slopes and valleys of the Himalayas. There the English for decades have expended extensive and successful labour to bring about good forestry conditions. India is the only country under British rule—not even excepting the mother country—in which rational forestry is practised to any extent.

"The enormous quantities of timber required by a big, richly populated country, developing at a lively rate like India is, will hardly be met from its own forests. Conscientious cultivation of these may, of course, decrease the demand for foregn timber, and thus, to some degree, aid in keeping down the world market prices, but in the long run it will not be able to hold them on the

same level at which they have generally stayed during this decade."

Thus writes a great Swedish authority—Professor Gunnar Anderson—in a review of the coniferous timber supply of the world, in which he urges his fellow countrymen to take steps now to increase their production. His final conclusions are worth quoting:—

"This inventory proves that really there are very few countries which by nature, position, and shipping possibilities, have a chance to produce and export to the world markets any wood products so advantageous to the country as Sweden. When in addition our investigation shows that the demand of the world is steadily increasing, whereas the supply of the world during the next decades is surely going to decrease, it is evident that we may confidently expect to get better and better values for the products of our woods. The main thing is to produce as much as possible, so that we shall have plenty to sell when the prosperous times come. We have still 20 or 30 years in which to prepare. It is important that we use this time well, that with our limited money supply we make every effort, painstakingly and with foresight, to invest as much as we can in the improvement of our woods. That this will prove highly remunerative to the generation coming after us there can be no doubt."

I.—Present Markets and Possibilities of Immediate Developments in the Himalayas.

Let us examine, in further detail, the possibilities which lie before our Himalayan coniferous (and chiefly pine) forests and our enquiry will naturally fall under two heads:—

(*a*) Major produce—*i.e.*, timber

(*b*) Minor produce—*i.e.*, resin and its products.

(a) *Timber.*—One result of the world war and the subsequent shortage of shipping has been to bring into high relief the dependence of India, for *coniferous* timber, on foreign countries. The statement below shows the imports of such timber into India for

the three years 1912-13, 1913-14 and 1914-15, from the principal countries :—

From	Quantity in tons.			Value in thousands of Rupees.			Average price per c. ft. 1 ton = 50 c.ft.
	1912-13.	1913-14.	1914-15.	1912-13.	1913-14.	1914-15.	
Austria and Germany.	3,420	6,072	1,621	2,07	3,96	1,07	in 1912-13 = Re. 1-3-3.
U. S. of America.	11,695	20,927	1,368	6,62	11,65	77	in 1913-14 = Re. 1-3-8.
All other countries.	1,741	3,390	2,683	1,45	3,12	2,78	in 1914-15 = Re. 1-10-3.
Total ...	16,856	30,389	5,672	10,14	18,73	4,62	...

The enormous drop in imports in 1914-15 has led to the inevitable timber famine, which is likely to continue for a time. But it is a striking commentary that India, with well over a million acres of coniferous forest directly under the Forest Department, should yet find it necessary to import 30,000 tons or $1\frac{1}{2}$ million c. ft. of *similar* timber from America, Europe and elsewhere. The requirements of coniferous timber in India, large as they are already, are growing rapidly, and would undoubtedly increase still more rapidly if adequate supplies of suitable timber were available on the spot. Some of the uses which may be mentioned are as follows :—

1. *Large timber* in baulks or squares 10", 12", up to 18" square and 16′ long and over, and similar timber sawn up into planks 1", $1\frac{1}{2}$", 2" and 3" thick. Such timber is used in large quantities by the Docks and Port authorities in Calcutta and Bombay, by the big shipping firms, by engineering firms, railways and others.

2. *Medium timber*, e.g., B. G. Railway sleepers, for which the demand appears to be immense, and for which our coniferous timbers—antiseptically treated—seem to be satisfactory. Building and constructional timber in 10′ and 12′ logs, and scantlings and planks also come in this category.

3. *Small timber.*—The demand for this appears almost unlimited and, with the industrial development of India, is bound to increase. All the chief manufacturing centres in India require timber for packing cases, for which our hill coniferous timbers are entirely suitable. As isolated, but typical, cases of *newly developed* industries, which require quite small timber, may be mentioned the Dixon Chemical Company of Dehra Dun (producers of thymol), who require 50,000 c.ft. of small planks per annum, and, again, the Cement Industry, whose timber requirements for cement barrels will probably run up to 2 lakhs of c.ft. per annum. Both these industries have been started since the war began.

It is important to realize that there is a demand for timber of small grades and sizes from the largest logs which can be brought out to the smallest material, even down to 2½′ long and 8″ diameter. This will enable our forests to be worked with very much greater intensity, an enormous advantage in every way. Many of the coniferous areas in the Himalayas have been under the Forest Department for 30 or 40 years, the question of making thinnings in the dense pole-crops—the result of careful protection—is becoming increasingly important, and the advantages of obtaining uses for this small timber are manifest. It will be noted that nothing has been said on the possibilities of production of mechanical pulp (for paper) and of matches—two of the commonest uses for utilizing coniferous timber. They have been purposely omitted. These are two industries which require Spruce and Silver fir and not Pine timber—and one essential is that the timber has to be delivered at Factory site at extremely cheap rates—3 or 4 annas per c.ft. Since Spruce and Silver fir are, from their habitat, less accessible and more costly to extract than Pine, it seems inevitable that these two industries cannot show the same financial results as the possible uses mentioned above, where up to 6 or 7 annas per c.ft. can be paid for the timber at rail-head or saw-mill. I do not wish to imply that Spruce and Silver fir will not pay for pulp or for matches, but if they will pay in these two industries, they will pay better as packing cases or planks, and *a fortiori*, Pine timber will pay better again.

Sufficient has perhaps been said to indicate the great possibilities which await an energetic and intensive exploitation of the timber from our Himalayan coniferous forests.

(b) *Minor produce.*—Resin and its products.

This section applies necessarily only to the Pine areas (and chiefly to the extensive Chir and Blue Pine areas), from which alone resin, in economic quantity, can be obtained.

The Resin Industry in the United Provinces and Punjab has now entirely passed the experimental stage, and all the preliminary difficulties connected with a new industry, the organization and methods of tapping, collection, and transport of the crude resin, the best methods of distillation, and production of high quality turpentine and rosin, the sales and development of new markets, etc., have now been overcome, and, after many years of endeavour, the industry is at last running on (comparatively) well-oiled wheels. The estimates for next year, of gross and nett revenue (exceeding 8 lakhs and 3 lakhs respectively), show it is no longer a toy or a failure.

At the present time, however, not even 10 per cent. of our Pine forests are being, or are even proposed to be, exploited for resin, so that here also we have the possibilities of enormous and most profitable development. The only difficulty in exploiting many of our Pine areas is their inaccessibility, and the impossibility of extraction by any form of land transport. It occurred to the writer that if it were possible to bring out the resin by the same means that the timber from these Pine forests is brought out, *i.e.*, by river floating, it might make it possible to work extensive areas at a profit. Preliminary experiments have been carried out in the United Provinces to solve this problem, and these show decided promise. The underlying idea of these experiments is very simple. If receptacles (*e.g.*, kerosene oil tins), filled with resin and sufficient air to keep them buoyant, are sealed up, *and can be protected from being punctured*, they will automatically float, and can therefore be brought out by river.

If it can be worked *at a profit*, the developments foreshadowed in the resin industry are important, and there appears no

reason why the gross revenue therefrom should not increase to Rs. ½ a crore per annum.

II.—NECESSITIES FOR FUTURE DEVELOPMENTS.

If it is agreed that a fair case has been made out for the possibilities of extensive development, it is advisable to enquire briefly what is necessary and what is advisable to enable these possibilities to be fulfilled.

1. In the first place we require capital, and plenty of it. Capital for saw-mills, capital for new and improved distilleries, capital for improving the means of extraction, *e.g.*, timber slides or rope-ways, improving water-ways (by dynamiting rocks), motor lorries on cart-roads, and similar measures; capital for initial outlay and development of new business, carrying stocks and the like. (This would get over the difficulty of having to show corresponding revenue within the same financial year, for any expenditure incurred, the impossibility of which is perhaps not always realized by the higher financial authorities.)

It may be pointed out, with considerable emphasis, that to attempt to pay all this capital expenditure out of ordinary forest revenues would be folly. The opportunity to develop these industries and seize the Indian market is with us *now*, while imported competition is at prohibitive prices, and we have here an exceptional case for a forest loan. True, money is expensive at present, and likely to be so for a long time, but even 5 per cent. for interest, and a further 5 per cent. for sinking fund would bear a very small proportion to the profits that would accrue.

2. Again, for such a development as is indicated, a substantial increase of the Department's cadre on the commercial side would be necessary, *i.e.*, trained managers, salesmen, selling agents and the like. There is no sense in using a razor to cut a grindstone, or a trained forest officer to sell timber or turpentine, or to run a mill.

3. In the third place, operations would be on a sufficiently large scale to justify a special research staff. For example, an engineer, expert in all forms of mechanical transport, in

mountainous country, and conversant with saw-mills and machinery, would be essential. Again, a special economist to be examining continually into new or more pofitable uses for coniferous timber, would have his time fully occupied. Again, a special technological chemist, to examine into the countless problems that yet await solution, would prove invaluable. To give one example only, if the phenomenon of "cracking" oil, and breaking down the high boiling polymers in Chir resin into the low boiling turpenes could be applied, the monetary gain would be considerable. The advantages in having special research officers with their duties and enquiries concentrated on the class of produce, would be immense, and although fully appreciating the excellent research work done at Dehra, it must be evident that one officer cannot examine into all the innumerable problems all over India, and that there is room for the suggestion made above without fear of overlapping.

III.—Possibilities of Development in the More Distant Future.

I have so far dealt with the possibilities of existing coniferous areas. The steady improvement and continually increasing output from these areas will automatically follow from the protection, conservation, and careful management which the Forest Department give to them, and have been giving to some of them for decades. But there are possibilities beyond this, which are worthy of consideration. The extension of our pine and coniferous areas by afforestation of bare hillsides has been tried on a small scale with some success, but we have not at present the necessary staff to carry out such work on a large scale. We have also enormous areas covered with useless or (economically) valueless forest, *e.g.*, the Oak forest. Would it not be possible to convert some of these into coniferous forests at comparatively small expense? The French converted 250,000 acres of desert sand into the valuable resin-producing forests of the Landes in 75 years, and all over the continent are numberless cases of conversion of broad-leaved into the more valuable coniferous forests,

There is undoubtedly a great opening here for similar profitable action, and extensive experiments should be started in various localities to test the possibility. By the time these experiments have advanced sufficiently to indicate if there is any prospect of success, the exploitation and development of the existing coniferous forests will have reached a point where the nett surplus will have increased enormously, and it will be an excellent investment to put back some of this surplus in new woods. Then, in the words of the Swedish professor, we shall "with our limited money supply be making every effort painstakingly and with foresight to invest as much as we can in the improvements of our woods. That this will prove highly remunerative to the generation coming after us, there can be no doubt."

FOREST RESERVATION IN BURMA.

BY H. C. WALKER, I.F.S.

Two articles were published in the *Indian Forester* for September 1916, signed, the one by Mr. Grieve and the other by Mr. Watson, dealing with the question of Forest Reservation in Burma. It has been the practice, when making a reserve, to exclude sufficient forest land so that any existing village can obtain its domestic requirements free without entering the reserved forest, and both writers point out that villagers, by their wasteful methods, gradually destroy the forest, and render the land set aside for them unproductive. A villager who requires timber for house-building selects the nearest suitable tree. Thus, at first, villagers may be able to obtain all the timber they require within a radius of one mile, but at the end of, say, ten years, only small timber is left, which is then cut down for fuel. During the next ten years the timber may be exhausted within a radius of two miles, and so the process of destruction goes on until all the forest in the vicinity of the village is destroyed.

The remedy advocated by both writers is reservation. As Mr. Grieve points out, a large proportion of the land not included in reserved forests is unfit for the production of field crops, and

cannot be put to a better use than for the production of forest produce, and therefore, theoretically, it seems only reasonable that such land should be brought under the control of the Forest Department and be managed on scientific principles. It is only when one goes into the question from the point of view of what is practicable that one finds that one is up against a very tough proposition.

The great proportion of land in the Province consists of waste forest land which, on the one hand, is unfit for paddy cultivation, and, under the policy hitherto adopted, has not been considered suited for forest reservation on the other hand. The areas to be dealt with under this proposal, therefore, would be immense.

Hitherto we have not made any attempt to regulate the supply of forest produce extracted by villagers, and seeing that there are some millions of inhabitants, each of whom requires annually a moderate amount of produce, it would be a very tall order to cater for their requirements.

Reservation is a somewhat elaborate and expensive operation. The area has to be examined and a rough sketch made; the villagers' claims have to be enquired into by two gazetted officers; and the area has to be demarcated according to rule. But reservation alone would be insufficient. These areas could not be closed for extraction, and schemes to regulate the outturn of each forest would have to be prepared without delay. The area of reserved forests is comparatively small, but in these, for the most part, we have only attempted to regulate the extraction of one species, and, for many reserves, it has not been found practicable to prepare any scheme at all. It is evident, therefore, that this proposal would involve a great amount of labour and expense.

Mr. Watson does not propose to recover these costs from the original inhabitants of a village, and it is possible that some of the more intellectual villagers might realize that he was actuated by the loftiest and most altruistic motives. The ordinary villager, however, has always been accustomed to obtain his supplies from the nearest available forest, and it is probable that he would cordially dislike having to fetch his supplies from a considerable

distance. By multiplying the number of subordinates he might be forced to comply, but any policy which is likely to cause considerable opposition must be difficult to carry out successfully.

As regards financing his scheme, Mr. Watson maintains that "undue stress is laid on revenue production to the exclusion of local interests," and goes on to say that "a 60 per cent. actual profit is expected instead of a legitimate 33 per cent." I gather from this that he advocates that nearly half our nett surplus should be utilized to finance his policy. It is, however, not unreasonable to consider whether there is any likely prospect of inducing Government to relinquish so large a portion of the revenue. According to the local Press, several crores of rupees—or at any rate, several lakhs of rupees—have to be handed over annually to the Indian Government, and the general administration of what is, in many ways, a backward and undeveloped country, has to be carried out with the balance. About half the forest surplus is a very substantial sum of money, amounting to many lakhs, and it can only be devoted to the proposed purpose by exercising economy in other directions. In what way can he suggest that the necessary economies should be effected? Is it practicable or desirable, for instance, to reduce expenditure on Public Works, the Police, or Education? Without expressing an opinion on this point I am quite prepared to hazard a prophecy that however heartily Government may sympathize with Mr. Watson's proposal, it will not find it convenient to forego any appreciable portion of the forest revenue.

I hold views almost diametrically opposed to those of Mr. Watson. I approve of the policy of excluding sufficient forest land for the requirements of adjacent villages, and, instead of taking up more reserves, would concentrate on those we have already acquired, and would attempt to reduce the cost of administration of unclassed forests. For the purpose of my argument, the forests of the Province can be divided into two classes: reserved forests brought under working-plans, and all other forests. The area of the first class is comparatively small, being about 8,000 square miles as against over 130,000 square miles of other forest land.

These forests, however, comprise all the more valuable teak forests, and it is from these that the bulk of our revenue is derived. For instance, the area of forests under working-plans in this division is roughly 500 square miles. The lessees, who of course confine their operations entirely to teak, estimate the revenue this year at well over six lakhs of rupees, almost the whole of which will have been derived from the area in question.

Although this class of forest yields a handsome revenue, it is capable of great development. Even in the most valuable teak forests the greater proportion of the growing stock consists of rubbish, which, except in very accessible localities, is never likely to become marketable. It may not be desirable to create pure teak forests ; but, leaving bamboos out of account, the proportion of teak could probably be increased to 50 per cent. with safety, and the more worthless species eliminated, so that the remaining 50 per cent. would consist of marketable species.

An important point to bear in mind is that a large proportion of our teak is exported from the country. It would, for instance, be possible to increase the forest revenues very largely by charging a small duty on bamboos extracted for domestic purposes, but the general effect of such a tax would be merely to raise the cost of living, whereas, when timber is exported from the country, goods to an equal value can be imported in its place, and thus the general wealth of the country is increased.

The question, therefore, arises whether we are devoting sufficient attention to the development and improvement of this class of forest. I have mentioned that a revenue of at least six lakhs is expected from the 500 square miles of teak forest in this division, and it may be interesting to compare the amount spent. A few thousand rupees are spent on fire-protection, which probably does more harm than good, a few thousands on improvement fellings, and a few thousands on roads. Excluding the cost of staff, the amount spent on developing these forests is well under Rs. 20,000, which naturally makes little impression on the forests. This is perhaps, in some ways, an extreme case, but I do not think it can be disputed that, although the proportion of expenditure to

revenue is about 40 per cent. for the whole of Burma, the proportion spent on the comparatively small areas referred to, is far less than this and is utterly inadequate.

My suggestion that greater efforts should be made to develop the forests from which we derive the bulk of our revenue is, I maintain, deserving of as great consideration as Mr. Watson's proposal to protect those forests from which villagers derive their local requirements. In both cases, the difficulty is one of establishment and funds. Mr. Watson solves the difficulty by pointing out that the remedy rests with Government. Should Government not see its way to allot larger funds, he considers that the responsibility would no longer rest with the Forest Department. His confidence in the Burma Government is most pathetic. At times forest officers have been deputed to foreign Native States, and on their return have complained that the only interest taken by the local potentates in forest matters is in the surplus forest revenue, and that any effort to improve or develop the forests, in the interests of future generations, only causes opposition or at best indifference.

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Hope is one of the three great virtues, and while hoping, therefore, that the Burma Government may see its way to allotting larger funds for developing its reserved forest, it may not be altogether superfluous to consider also the question whether funds could not be obtained by effecting economies in the administration of unclassed forests and useless reserves.

As regards this second class of forest, Government reserves to itself the right to all forest produce on waste land, but as villagers have been given the privilege of obtaining their domestic requirements of timber and fuel, free of duty, within a radius of ten miles, these forests bring in little revenue. Government has, in fact, little direct interest in these forests, and it is principally the humble villager who suffers when they are destroyed. The question, therefore, suggests itself whether the villagers could not be induced to take a greater interest in the protection of these forests.

*It has been found necessary to omit a paragraph.—HON. ED.

Personally I think this could be done by Government giving up some of its claims to forest produce on waste land, and by handing them over to villagers. All unclassed forest is already divided into village tracts and, by a stroke of the pen, the unclassed forests could be allotted to the villagers, within whose tracts it is situated. Whereas at present any villager can obtain his domestic requirements from any unclassed forest within a radius of ten miles from his village, I would suggest that he should be restricted to the forests within his village tract. If he could not obtain what he wanted, he would have to apply to the villagers of another tract for permission, free or on payment, to extract his requirements from their forests, or would have to purchase his supplies through a local trader.

Teak would still remain a royal tree, and Government would still reserve to itself the right to reserved trees, but the question might be considered of allowing any such tree found in the village tract to be utilized, without license, for repairing the headman's house, monasteries, zayats (village rest-houses) and bridges.

There remain two further points to be considered : namely, the questions of local trade and future reservation. When a person buys forest produce through a local trader, the price includes the royalty charged by Government. Government stands for the interests of the community as a whole. If, therefore, a person is prepared to pay as it were a fine to the general community for his slackness in not preserving sufficient timber in his village tract, I would allow him to obtain his supplies through a local trader from any village tract. In other words, Government would not entirely surrender its rights to the local inhabitants, but would retain the right to dispose of any forest produce to a trader willing to pay the usual rates of royalty. I would go even further. Government would be conferring very valuable privileges on local inhabitants, and in return, I think it would not be unreasonable to require them to protect the interests of the community at large. In order to prove that a trader is entitled to extract timber from a certain village tract, I would provide that he should show the headman his license, and I would hold the village collectively

responsible that its conditions are observed, and that, for instance, the licensee does not fell any tree under the prescribed girth limit. On the other hand, when any such offences are reported by the headman or villagers, half of any sums received as compensation might usually be handed over to them.

For the most part timber traders require timber of large size, and therefore would usually avoid village tracts, where the scarcity of timber is becoming acute. But nevertheless, as time goes on, it may be necessary to discriminate between the interests of the community at large and those of local communities. For instance, if in a certain village tract the villagers had the enterprise to plant up a portion of the waste land at their disposal, it would not be fair that traders, by virtue of the payment of a small royalty, should be allowed to remove the produce. I would therefore provide that, if any village could show sufficient cause, the village tract should be closed to extraction for trade purposes.

As regards reservation, I am of the opinion that we have already bitten off more than we can conveniently chew, and have reserved an area sufficiently large to tax to the utmost the energies of the present staff or of any increased establishment which is likely to be sanctioned in the near future, to administer and to develop it in a satisfactory manner. I am of the opinion, therefore, that little further reservation is necessary, and even think that some of our existing reserves could, with advantage, be thrown out. Nevertheless, it must occasionally happen that reservation may be necessary. Although village communities would acquire certain rights over forest produce, I do not propose that this should debar a person from taking up land covered with forest growth for the purpose of the permanent cultivation of field crops, or the Forest Department from acquiring land in the interests of the whole community for the permanent cultivation of forest crops. In the latter case, an enquiry would be held as at present, and sufficient land excluded to provide for the reasonable requirements of adjacent villages.

It would be interesting to know exactly how existing communal and village forests originated in those countries in which

they are found. If one considers the matter, however, it seems highly improbable that the State acquired possession of waste land, planted it up, and when the woods had come into bearing, handed them over to village communities. It would obviously have been unfair that every village should, in the form of State taxes, have subscribed to the cost of these planting operations, and that only a limited number of fortunate villages should have benefited. It is very much more probable that when acquiring land for the purpose of forming State forest, the central Government refrained from taking up waste land over which neighbouring villages had acquired rights, and that the villagers themselves recognizing the desirability of ensuring a permanent supply of timber and firewood, planted it up. The fact that, in many cases, village forests are managed by State forest officials, may seem to indicate that these forests originally formed part of the State forests, but a more probable explanation is that, as gradually an intensive system was evolved, requiring skilled management, the village communities arranged with the central Government for the part services of its trained forest staff on payment of the estimated annual cost.

I maintain, therefore, that we should adopt the policy which appears to have been followed in those countries in which forestry has been carried on most successfully. In the first place, Government should concentrate its attention on acquiring large compact blocks of forests in areas remote from population, and on developing them for purposes of revenue. There are few countries with such valuable natural forest resources as Burma, and if properly developed, these State forests should prove a source of great wealth to the Province.

Timber and even firewood is bulky and expensive to transport to any distance, and therefore it is of great importance to ensure an adequate supply of forest produce as close to each village as possible. In this respect also we are fortunate in Burma, as the amount of forest land available for this purpose is enormous, and therefore there should be no difficulty in making adequate provision. The principal obstacle seems to be that Government,

while refusing to allow villagers to protect or to develop the waste forest land close to their villages, neglects to protect it on their behalf. In this country, there is a strong tendency to adopt a grandmotherly attitude of mind towards the humble villager. The Burman is said to be notoriously improvident, and as he is not supposed to be able to look after his own interests, it is always assumed that some time or other the Forest Department will take steps to regulate his supply of timber and firewood on his behalf. As yet nothing has been done on these lines, and if one takes the limited resources of Government into account, it seems certain that nothing will be done, until there are hardly any forests left to protect. It is quite true to assert that it is the villagers themselves who destroy the forest, but the real cause is that the policy of Government encourages every villager to extract his requirements from the nearest possible area. If villagers were given a certain amount of control over the waste forest land in their village tracts, as suggested, it would be to their interests to preserve sufficient produce for their own requirements and to dispose of any balance which they could spare for as high a price as possible. Thus, near congested areas, high prices would be charged, and this would at once tend to spread extraction to remoter areas, where supplies are more abundant.

At present it is not unusual to find taungyas being cut in areas where already the scarcity of timber is being felt, but if villagers were allowed to make a profit out of timber and firewood, they would begin to realize the folly of allowing it to be used for manuring a temporary crop, and the tendency would be to drive taungya cutters to more remote localities where their wasteful and pernicious methods would be less injurious to the community.

The amount of waste forest land varies considerably in different village tracts, and, to my mind, the principal objection to the scheme is that, in many places, villagers who hitherto have been able to obtain all they want, within a radius of ten miles, would suddenly be called upon to purchase all their supplies. If, however, the policy is continued of allowing produce to be extracted free, it is inevitable that the forests will be gradually destroyed

for long distances round large centres of population. The cost of forest produce depends principally on the distances to which it has to be transported, and therefore it is preferable that, in such cases, villagers should suffer a certain amount of hardship now, rather than that in a few generations the price of forest produce should be almost prohibitive. Moreover, the difficulty can be easily exaggerated. A scarcity of timber and firewood is usually counterbalanced by other advantages. For instance, villagers in the Delta may have to purchase all their supplies of forest produce but, owing to the high price they obtain for their paddy, they are, on the whole, very much better off than villagers in remote parts of the Upper Chindwin, where excellent forest growth is often found close at hand. Similarly, villagers living close to the railway line would suffer to a certain extent but, in most cases, they could well afford to pay for their supplies, and this scheme would encourage villagers, living within easy reach, to cultivate their forests and to cater for these requirements.

Probably this scheme would cause the greatest hardship in the dry zone, where already the struggle for existence is severe, and would result in a number of jaggery boilers having to give up work. In these localities the demand for fuel is greater than the supply and, therefore, unless the forests are to be utterly destroyed, the supply must be restricted, and this cannot be done without causing hardship. The Forest Department has, I believe, made some attempt to deal with the problem, but I doubt whether the results have given us much cause for satisfaction, or that they have earned for us the gratitude and respect of the humble villager. The idea of handing over the forest produce to the villagers, within whose tracts it is situated, was first suggested to me by the Settlement Officer of the Pakokku district, and although in this district the scheme would cause the maximum amount of hardship, it is precisely in such localities, where the scarcity of fuel is most acute, that it would ultimately do the greatest good, and I am confident that if villagers were consulted—and after all it is they who are most nearly concerned in the question—they would welcome this solution of the difficulty.

In the present stage of development of the Province, it should be our aim to avoid finality, and merely to lay the foundations of a sound policy. For instance, even if it were practicable to do so, it would, in my opinion, be a great mistake to demarcate a patch of forest for each village, and to set it permanently aside as a village forest. Communications will gradually be improved, and land, which is useless at present, owing to its remoteness from the markets, will be taken up for the cultivation of field crops. Again, although at present paddy can only be cultivated on alluvial plains, and is practically the only crop, it is quite conceivable that there will be further developments in agriculture. Seeing that, as a general rule, field crops are more valuable than forest crops, it is desirable that the natural and healthy development of the Province should not be prejudiced by too stringent a forest policy.

The slight measure of control which it is proposed to give to villagers will not prevent waste land being put to the best possible use. A time will come, however, when, as at present in Europe, it will be necessary to cultivate forest crops, and already in Burma we have reached a stage at which high prices can be obtained for forest produce grown close to large centres of population. It would not repay the Forest Department to take up land honey-combed with cultivation, and burdened with rights and privileges, but near large towns it would well repay villagers to look carefully after every scrap of forest land, and, in places near the railway, to plant up even small patches of waste land with bamboos or trees for firewood. It will be many years, however, before true, well-regulated village forest will be formed, such as are found in Europe. It is inevitable that, in the remoter parts of the country, the miserable villager will continue to waste the bountiful gifts of Nature, but as the intelligence of the people improves and the price of timber increases, it is conceivable that greater care will be taken to protect the village supply of timber and firewood and thus imperceptibly, as the centuries roll by, the waste land may be converted into well-managed village forests.

It is my misfortune to disagree with Mr. Waston on one or two points, but after all our opinions differ only on minor matters

of detail. The main question at issue is the rapid disappearance of the forests outside reserves, and I cordially agree with him that some action should be taken immediately to protect these forests and to arrest the process of destruction. It is our practice in Burma to ignore facts as long as we can and, when they are forced on our notice, to wring our hands piteously and mournfully to complain that the question is a very vexed one. The last thing we do is to tackle the problem in a business-like manner, and to attempt to arrive at a sound conclusion as to how best it may be solved. Fortunately, the area of forest land is immense and the population scanty, and during my time at least it seems unlikely that we shall be reduced to the expedient of using cow-dung as fuel, but if the process of destruction continues unchecked, there seems every prospect that my great-grandchildren and their descendants will have the greatest difficulty in obtaining their supplies of timber and firewood. The one faint ray of hope is that, by that time, Mr. Watson may have developed his "timber transport by airship," and that he will be able to supply their needs out of the remote and, at present, inaccessible Government reserves.

STANDARDIZATION OF TREE MEASUREMENTS.

BY A. E. OSMASTON, I.F.S.

A leading article appeared with the above heading in the November number of this Journal for 1909, and was followed by a reply from Mr. Haines in the number for March 1910.

The original article affirms that there are two principal systems of measuring trees at present in vogue in India. According to one system, measurements are made by girth, in 18″ periods, trees over 6′ in girth being called first class trees. According to the other system, measurements are made by diameter, in 6″ periods, trees over 2′ diameter being called first class trees. Thus a first class tree, according to the second system, has a girth about $\frac{2}{7}$ of a foot greater than according to the first system. The article then goes on to advise that one or other system be standardized, and the system of girth-measurement is shown to be preferable, on account

of its greater accuracy. It is recognized, however, that, for many working-plans and other purposes, 18″ periods are too large ; and, moreover, further differentiation above 6′ may be necessary. In the latter case an M class is suggested for trees above $7\frac{1}{2}'$ girth.

Mr. Haines, in referring to the above, expresses a hope that the change, if made, may be more radical, and he considers it of no importance, that 18″ classes have practically become standardized. He says the periods should be small and arranged on some simple plan, so that their meaning may be easily grasped by novices and foresters of other countries. Foot-classes best fulfil these conditions. The Honorary Editor adds a note to the effect that if a radical change is contemplated, it would be best to adopt 1-foot girth classes.

Now, I fully endorse all that I have quoted above, only that I would go still further. It is surely a very clumsy method which, commencing at 5th class, works up backwards to 1st class and then changes to a quite new terminology, embracing the letters of the alphabet. Obviously, the most simple method would be to commence with class I and go on with classes II, III, etc., in proper sequence *ad infinitum*, each class corresponding to 1 foot in girth. This, I propose, as the standard method for the future, and it is worth considering what would be the advantages and disadvantages of such a change. The principal advantages of the method are, undoubtedly, its absolute simplicity and its perfect elasticity, which enable it to include trees of even the largest girths. Against this must be weighed all the disadvantages which arise from any sudden and radical change of this nature. These disadvantages would, however, no longer have any weight, could it be shown that they are bound to appear whether the particular method I have advocated is introduced or not, and this, I think, can be shown on the assumption that the present 18″ classes are too large for a permanent standard. For, if you once alter your period, you must alter the number of classes between 0′ and 6′ girth, so that a change of period, however slight, entails a radical change all through. And I think my assumption is reasonable, for a reduction to 1-foot classes has already become practically established in some parts of India,

I admit that it would be possible to have a 9″ period, so that each of the presant 18″ classes is sub-divided into two, which might be called "*a*" and "*b*" (thus I *a* would include trees between 6′ and 6′ 9″ girth); but such a system would be an even greater terminological puzzle than the present, and would therefore still entail most of the disadvantages inherent in the existing systems. Again, the old value attached to the term "a first class tree" is largely due to this class coinciding with a class of trees considered fit for felling, but this meaning is rapidly dying a natural death, as more accurate determinations of the exploitable girths of different speceis are obtained. For instance, the exploitable girth of Sal has recently been reduced to 5′ in an important working-plan in the United Provinces, and similar examples are multiplying rapidly, so that the 6′ exploitable girth, which has been found till now so convenient to apply to an indefinite number of species, is already being relegated to the barbarous past.

In conclusion, therefore, I maintain that a radical change in our present method of classification is inevitable, and could not now be postponed for long, even were it thought desirable to do so. The form such a change shall assume is the problem remaining to be solved, and the method I have outlined above is the solution that seems to me both best and simplest. It seems, moreover, anything but desirable to postpone this important matter any longer, for the longer it is postponed, the greater becomes the accumulation of valuable data according to a system which must eventually disappear.

[We should heartily welcome the general acceptance of the above suggested change in the standards of tree measurement, which we consider to be the only rational system, and that the arguments in favour of its adoption largely outweigh any possible objections.—HON. ED.]

CORRELATION BETWEEN THE LIGHT AND SOIL REQUIREMENTS OF A SPECIES FOR ITS NATURAL REGENERATION.

BY B. O. COVENTRY, I.F.S.

Given sufficient warmth and moisture, most seed will germinate, but in order that the seedlings may develop into well-established plants, or, for natural regeneration to take place, the seedlings require, in addition, suitable conditions of light and soil.

LIGHT CONDITIONS ON THE SOIL.

Protection of the soil from the direct rays of the sun not only involves a diminution in the actinic power of the light on the soil, but also a reduction in the heat effects of the sun, so that in speaking of the light conditions, both light and heat are implied.

The light conditions on the soil are dependant on two factors, namely: (1) the locality, *i.e.*, its elevation, aspect and gradient; and (2) the canopy of the vegetation. On the plains, the light conditions on the soil are dependant on the density of the canopy of the vegetation only, but on the hills, for places at the same elevation, the influence of aspect and gradient has also to be taken into consideration. For example, on a steep northern aspect which receives little direct sunlight, the light conditions are very different to those on a southern aspect, quite apart from the density of the canopy of the vegetation, and consequently the light conditions on a northern aspect under an open canopy of the vegetation may be similar to those under a denser canopy on a southern aspect.

The light conditions on the soil vary from conditions where the soil is entirely unprotected from direct sunlight, to conditions where it is completely protected; but, for practical purposes, the following three conditions of light on the soil may be distinguished :—

(1) Maximum light conditions, *i.e.*, where the soil is entirely unprotected from direct sunlight.

(2) Moderate shade conditions, *i.e.*, where the soil is partially protected either by a light canopy of vegetation, or by the aspect, or by the combined influence of both the vegetation and the aspect.

(3) Heavy shade conditions, *i.e.*, where the soil is more or less completely protected, either by a dense canopy of vegetation, or by the aspect, or by the combined influence of both the vegetation and the aspect.

LIGHT REQUIREMENTS OF DIFFERENT SPECIES FOR THEIR NATURAL REGENERATION.

In considering the light requirements of different species for their natural regeneration, it will be found that certain species such as Jand *(Prosopis spicigera)*, Shisham *(Dalbergia Sissoo)*, Phulai *(Acacia modesta)*, Chir Pine *(Pinus longifolia)*, Blue Pine *(Pinus excelsa)*, Edible Pine *(Pinus Gerardiana)*, etc., regenerate in the open on soil exposed to the full glare of the sun, or under maximum light conditions, whereas others, such as Mulberry *(Morus alba)*, Olive *(Olea cuspidata)*, Deodar *(Cedrus Libani)*, Silver Fir *(Abies Webbiana)*, etc., do not regenerate on soil fully exposed to the sun, but require a greater or less degree of protection from direct sunlight, or shade. The former species may be termed "Non-shade-demanders" and the latter "Shade-demanders." Of the latter, some require greater protection than others, and a distinction may be made between "Moderate shade-demanders" and "Heavy shade-demanders."

The different species may accordingly be classified, according to their light requirements for natural regeneration, into the following three groups :—

1. Non-shade-demanders, *i.e.*, those species which regenerate on soil exposed to the full glare of the sun, or under maximum light conditions, *e.g.*, Jand *(Prosopis spicigera)*, Shisham *(Dalbergia Sissoo)*, Phulai *(Acacia modesta)*, Chir Pine *(Pinus longifolia)*, Blue Pine *(Pinus excelsa)*, Edible Pine *(Pinus Gerardiana)*.

2. Moderate shade-demanders, *i.e.*, those species which require moderate protection or shade from the sun for their natural regeneration, *e.g.*, Mulberry (*Morus alba*), Olive (*Olea cuspidata*), Deodar (*Cedrus Libani*), Spruce (*Picea Morinda*).

3. Heavy shade-demanders, *i.e.*, those species which require considerable protection or shade from the sun for their natural regeneration, *e.g.*, Silver Fir (*Abies Webbiana*), and possibly such species as Rhododendron, Holly, Yew, etc.

On the hills, the effect of elevation, aspect and gradient on the light conditions on the soil must be borne in mind. For instance, a species which is normally a "Moderate shade-demander" may appear to be a "Heavy shade-demander" at a low elevation on a hot aspect, or a "Non-shade-demander" at a high elevation on a cool aspect, if judged solely by the amount of protection which it requires, as given by an overhead canopy of vegetation. Natural regeneration of Deodar is sometimes found to take place in the open, without any protection from an overhead canopy; and, in other localities, it is found to take place only where the soil is protected from the sun either by shrubs or trees; so that it is not always easy, at first sight, to determine the light requirements of a species growing on the hills. In order to obtain a correct idea of the light requirements of different species growing on the hills, for comparison with each other and with species growing on the plains, the influence of aspect must be eliminated by considering under what conditions natural regeneration would take place if the species were growing on a level plain at the elevation of their optimum growth, which, in the case of Deodar, would be at about 7,000'. Under these conditions, natural regeneration of Deodar would not take place without moderate protection from the sun,

and so Deodar would be rightly classed as normally a "Moderate shade-demander."

Shade-demanding species require protection from the sun, only during their early years; for, later on, they grow perfectly well with full exposure to the sun, but, at the same time, are adapted to bear more or less shade. They thus gradually lose their shade-demanding character and become simply "Shade-bearers"; but it is important to bear in mind that the term "Shade-bearer" implies, in addition to its ordinary meaning, that such species are also shade-demanding for the purposes of their natural regeneration.

From the fact that shade-demanders only require protection from the sun during their early years, and also from the fact that the actinic power of light is almost as great in good diffuse light as in direct sunlight, it seems probable that it is protection from the heat effects of the sun rather than from the actinic power of the light, which shade-demanders require for their natural regeneration.

SOIL CONDITIONS.

Soil, whether found *in situ*, from the disintegration of the sub-soil rock, or by the deposit of sediment by river is, prior to the growth of vegetation on it, a mineral soil containing no humus. Humus may subsequently be added to the soil by the decay of vegetable débris from the vegetation growing on it.

The importance of humus in a soil is due to its possessing the two following characteristics :—

(1) It contains compounds rich in nitrogen.

(2) It possesses physical properties which enable it to act like a sponge in retaining moisture.

A soil, without humus, is usually deficient in nitrogen compounds. The more water retained in the soil the less the amount of air in it, so that the accumulation of an excessive amount of humus in a soil may, under certain climatic conditions, owing to its sponge-like property of retaining moisture, result in changing a soil which was previously well-drained and well-aerated, into one which is wet and badly aerated. The addition of humus, therefore, introduces new factors into a soil changing its properties very

considerably. Thus a non-humus soil deficient in nitrogen may change into a humus soil rich in nitrogen, and a well-aerated humus soil may change into a badly aerated soil or even in an extreme case to an acid soil. On the hills, owing to the low temperature and heavy rainfall, the change, from a well-aerated humus soil to a badly aerated soil, may be frequently met with; but, on the plains in the Punjab, badly aerated soil due to excess of humus is rarely, if ever, met with.

The following three types of soil may be distinguished, the two latter types being advanced stages in the evolution of a soil from its original non-humus condition:—

(1) Non-humus soil, *e. g.*, deficient in nitrogen compounds.
(2) Moderately humus or well-aerated humus soil. } rich in nitrogen compounds.
(3) Excessively humus or badly aerated humus soil. } rich in nitrogen compounds.

If humus is exposed to the sun it becomes rapidly oxidized and dissipated into the atmosphere in the form of gaseous matter, so that whether humus will be added to a soil or not, and, if added, the amount and rate of its accumulation depends on the degree of protection afforded to the soil from exposure to the sun, or, in other words, to the light conditions. Non-humus soil is found where the soil is exposed to the full glare of the sun; moderately humus soil where it receives moderate protection or under moderate shade conditions; and excessively humus soil where it receives considerable protection or under heavy shade conditions. It may therefore be broadly stated that, in the same locality or for localities with the same climatic conditions, the amount of humus in the soil is proportional to the light conditions; or, in other words, there is a correlation between the light conditions and the soil conditions.

CORRELATION BETWEEN THE LIGHT AND SOIL CONDITIONS FOR NATURAL REGENERATION.

If a correlation exists between the light conditions and the soil conditions, it follows that there must be a correlation between the light and soil requirements of a species for its natural regeneration;

for, if a species in the process of its evolution has become adapted to regenerate on one peculiar type of soil, it must also have become adapted to regenerate under those light conditions which are associated with that type of soil. Consequently, species adapted to regenerate on a non-humus soil are also adapted to regenerate with full exposure to the sun, these being the light conditions associated with a non-humus soil. Similarly, species adapted to regenerate on moderately humus or excessively humus soil are also adapted to regenerate under moderate shade and heavy shade conditions respectively. Thus, if the light conditions required by a species for its natural regeneration are known, the soil conditions which it requires can be more or less deduced therefrom, or *vice versâ*.

It follows, therefore, that "Non-shade-demanders," such as Jand (*Prosopis spicigera*), Shisham (*Dalbergia Sissoo*), Phulai (*Acacia modesta*), Chir Pine, Blue Pine, Edible Pine, etc., are adapted to regenerate on non-humus soil; "Moderate shade-demanders," such as Deodar, are adapted to regenerate on moderately humus or well-aerated humus soil, and "Heavy shade-demanders," such as Silver Fir, are adapted to regenerate on excessively humus or badly aerated humus soil.

These deductions are corroborated by actual observations of the conditions, under which natural regeneration of the species mentioned takes place in the forests. The "Non-shade-demanders" mentioned are all known to regenerate on non-humus soil and it will be noticed that they either belong to the family *Leguminoseæ* or are Pines, and are thus able to obtain their nitrogen requirements from the air by means of nodules on their roots or mycorhyza, which makes them independent of humus in the soil. Deodar, which is a "Moderate shade-demander," regenerates on a well-aerated humus soil and does not tolerate an excessively humus and badly aerated soil; whereas Silver Fir, which is a "Heavy shade-demander," regenerates on excessively humus soil on which natural regeneration of Deodar will not take place, and it is a common occurrence to find Silver Fir replacing Deodar in forests of the latter species.

A change in the soil from a non-humus condition to a humus condition is followed in Nature by a rotation of crops, or a change from a non-shade-demanding species to a shade-demanding species. Thus Shisham (*Dalbergia Sissoo*) becomes replaced by Mulberry (*Morus alba*), Phulai (*Acacia modesta*) by Olive, Chir Pine by *Quercus incana* and so on. Similarly, a change from a well-aerated humus soil to a badly aerated soil will also be followed by a change in the species, as in the case of Silver Fir replacing Deodar. As the change in the soil may take place rapidly, as compared with the age of the crop growing on it, a species may be found growing on a soil unsuited for its natural regeneration.

Taking into consideration both the light and soil conditions required for natural regeneration, the different species may be classified into the following three groups :—

1. Non-shade-demanders, *i.e.*, those species adapted to regenerate under maximum light conditions and on non-humus soil, *e.g.*, Jand (*Prosopis spicigera*), Shisham (*Dalbergia Sissoo*), Phulai (*Acacia modesta*), Chir Pine (*Pinus longifolia*), Blue Pine (*Pinus excelsa*), Edible Pine (*Pinus Gerardiana*).
2. Moderate shade-demanders, *i.e.*, those species adapted to regenerate under moderate shade conditions and on well-aerated humus soil, *e.g.*, Mulberry (*Morus alba*), Olive (*Olea cuspidata*), Deodar (*Cedrus Libani*), Spruce (*Picea Morinda*).
3. Heavy shade-demanders, *i.e.*, those species adapted to regenerate under heavy shade conditions and on badly aerated humus soil, *e.g.*, Silver Fir (*Abies Webbiana*), Holly, Yew, Rhododendron, etc.

From the above remarks it will be seen that, in so far as those species are concerned which form gregarious forests in the Punjab, there is a distinct correlation between their light and soil requirements for natural regeneration. If this can be accepted, it may help to indicate the measures to be adopted, in order to ensure the regeneration of the forests where difficulty in their regeneration is met with. For instance, in order to obtain natural regeneration of non-shade-demanding species, the obvious method of treatment is to open out the canopy sufficiently to expose the soil to direct sunlight, in order to introduce the necessary light conditions ; and also, to diminish or destroy the humus which may have accumulated in the soil, in order to bring the soil into a condition favourable for the regeneration of the species which it is desired to regenerate, and unfavourable for the growth of other vegetation against which the non-shade-demanding species may have to compete, if the humus is not partially or completely got rid of. Similarly, to obtain natural regeneration of a moderate shade-demanding species, the canopy must be opened out to allow sufficient light on the soil while, at the same time, allowing sufficient protection of the soil from direct sunlight ; and also, to destroy any excess of humus, if the soil has become badly aerated owing to the excessive accumulation of humus, such as is often the case in many of the Deodar forests. The extent to which the canopy must be opened out will depend on the elevation, gradient and aspect of the locality. It might be considered that the mere fact of opening out the canopy would in itself be sufficient to bring about the necessary rejuvenation of the soil where this is required ; but experience shows that, in many cases, this is not so, and that the opening out of the canopy simply results in the soil becoming covered with a dense growth of weeds and shrubs, which necessitates additional measures being undertaken, such as the opening of the forests to heavy grazing, or the running of a fire over the soil, etc. In the case of a shade-demanding species, where the canopy is already very open, and there is consequently an absence of humus in the soil, or where the humus soil has been denuded, as in the case of the Olive forests in the Rawalpindi Division, the only

means of obtaining natural regeneration is to protect the soil to allow humus to accumulate.

It must be borne in mind that the above remarks are only concerned with the light and surface soil conditions as affecting natural regeneration, and that other factors may be concerned: for instance, the failure of natural regeneration in the Jand (*Prosopis spicigera*) and natural Shisham (*Dalbergia Sissoo*) forests is due to a change in the topography resulting in the lowering of the water-level; and natural regeneration from seed in this forest could only be obtained by artificial watering, and not by any measures which would alter the light or humus conditions of the soil.

In the above note the terms "Non-shade demanders" and "Shade-demanders" correspond to the usual terms "Light-demanders" and "Shade-bearers" respectively; but these latter terms do not appear to be appropriate, inasmuch as all species require light, and all species bear more or less shade; whereas, on the other hand, certain species do not appear to require any degree of shade, whilst others do require more or less shade: so that terms expressing the shade requirements for natural regeneration appear to be more appropriate.

JODHPUR PRODUCTS.

BY S. N. CHATTERJI, LIBRARIAN AND MUSEUM ASSISTANT, FOREST RESEARCH INSTITUTE.

The Marwar Durbar has presented the Forest Research Institute with an interesting collection of samples of Economic and Industrial products of the State.

These consist of about 50 specimens of manufactured articles of different kinds of woods and minor forest produce and some 85 samples of minerals. The more important of these specimens are briefly described below :—

A.—FOREST PRODUCTS.

I.—WOODWORK.

1. *Boswellia serrata* (Sáler).

The Superintendent of Forests, Mr. Chatar Bhuj, states that the wood of this tree has hitherto been much neglected. A

paper-rack made of this species displays the utility of wood in cabinet work. It takes a fine polish on a dark brown surface. The Superintendent draws the attention of Forest Officers to the possible uses of this wood.

2. *Odina Wodier* (Gol).

The timber of this tree has also been much neglected. The Marwar Timber Factory use it now in carving work. An ornamental presentation casket made of this wood, with the name of the Forest Research Institute inscribed upon it, by inlayings of *Wrightia tinctoria* and *Diospyros Melanoxylon* shows off the wood to advantage.

3. *Tecoma undulata* (Rohira).

A water basin and jug, a cup and the idols of Gauri and Ishwara (the Hindu god and goddess of prosperity) are the principal exhibits made of this wood. None of them show signs of warping or cracking. The timber, therefore, appears to deserve the name of "Marwar teak" given to it by the Superintendent of Forests.

4. *Wrightia tinctoria* (Khirni).

The most interesting articles made of this wood are a tea-set, a mounted cup, the figure of a lion, and a stationery rack with pen-holders. These holders compare favourably with the Bavarian type. The retail prices are very moderate.

II.—LACQUER WORK.

The centre of this industry is at Bagri. It is not an altogether new industry, but has been developed only recently. Toys, chessmen, a collar box, a tobacco jar, and mirror stands are among the exhibits.

The chief woods used in the lacquer work are *Cratæva religiosa, Tecoma undulata, Wrightia tinctoria* and *Zizyphus* sp.

III.—IVORY WORK.

A factory has been started at Merta and appears to be doing well. Several articles including an imitation rose, a bracelet, a

pearl case, a walking stick and a pen-holder are shown. All show very fair workmanship.

Articles are also manufactured from Khas-khas grass at Merta.

IV.—ROCKS AND MINERALS.

A valuable collection of rocks and minerals found in Marwar constitutes not the least interesting portion of the exhibits.

It includes the following :—

(1) Specimens of marbles of various colours and qualities.

(2) Wolfram.

(3) Cobaltiferous manganese ore containing also copper and nickel in appreciable quantities.

(4) Graphite, impure.

(5) Asbestos. This is being worked experimentally.

(6) Chalcedony.

(7) Felspar (pink).

(8) Soapstone.

(9) Mica, of three kinds.

(10) Calcite.

(11) Gypsum, an excellent cementing material.

(12) Selenite.

(13) Limestone.

(14) Fuller's earth.

(15) Common salt.

The preparation of the last named substance, obtained mainly from the Sambhar Lake, constitutes the chief and most important industry of the State.

In addition to the above, saltpetre, carbonate of soda, kaolin and yellow ochre occur to a limited extent.

The Superintendent of Forests, Jodhpur, has intimated his willingness to reply to any enquiries relating to any of the above products.

It is hoped that the example of this progressive and enlightened State will be followed by others who must be equally anxious to find markets for their indigenous products and to develop local industries.—[*Hon. Editor.*]

REGENERATION OF TEAK IN THE MUNDGOD POLE FORESTS OF NORTH KANARA.

BY J. D. REGO, FOREST RANGER.

These forests have been worked as Coppice-with-Standards since 1908. About 30 standards are reserved per acre. It was hoped that seed from the standards, helped by a little planting, would ensure a sufficient crop of seedlings in the year following the felling, but this hope was not fulfilled. The opening of the canopy was followed by a heavy growth of grass, which choked and killed back nearly all the natural seedlings as well as most of the transplants. At the beginning of the rains, the ground was covered with many thousands of natural teak seedlings, but very few of these survived. Weeding operations were, therefore, started in the year 1912 on much the same lines as in the Haliyal Range of N. D. Kanara, where the work was begun about the same time by Mr. Copleston, who has described the work done in an article published in the *Indian Forester* of September 1914.

The work in Mundgod Range has been developed on somewhat different lines, and it is the object of this article to describe the experience gained here.

In Haliyal Range the teak seedlings were weeded during the rains, mulched with grass and earth at the end of the rains, and sheltered by bundles of grass during the dry season. This had to be continued for two or three years until the plants were big enough to be safe from suppression by grass. Work was started on the same lines in Mundgod Range, and the following changes have since been introduced with good results.

It was found that the growth of natural seedlings left *in situ* was very slow and that, after three years, they were still less than one foot high. Seedlings, however, which were dug up from one place and transplanted in another showed a better rate of growth, due probably to the loosening of the soil, which allows the roots to penetrate more easily.

Small seedlings of two or three inches high are the best for transplanting. Large numbers of these are found early in the

rains on fire-lines and road-sides, and the supply is augmented by the establishment of small nurseries in the coupes. In the hot weather, leaves and branchwood are burnt on the sites of these nurseries, and seed is then sown; seedlings come up at the beginning of the rains.

Even transplants show a slow rate of growth unless the ground in which they are planted has been prepared by the burning of rubbish. The plan now followed is to heap up all the firewood and waste wood (of which large quantities are left in every coupe), and to burn these heaps in the hot weather immediately after a shower of rain, when there is little fear of the fire spreading. It is not advisable to burn the whole coupe, as this induces a strong growth of grass; but on small patches where heaps of rubbish have been burnt, there is little or no grass for the next year or two. Teak seedlings planted on such burnt patches show a very good rate of growth, from one to two feet in the first year, and no weeding is needed at all.

Planting is, therefore, done on burnt patches as much as possible, but many plants are also put out on unburnt soil. These are weeded during the rains. Formerly they were mulched with grass and earth; but it was found that the grass attracted termites, which in their turn attracted wild pig, which did much damage by rooting up the plants. So the plants are now merely earthed up at the end of the rains, and no grass is used.

Sheltering of the small plants by bundles of grass was resorted to for some years; but it was found that the sheltered plants became rather lanky and weakly, and if a fire occurred the plants suffered very severely; so last year 10 per cent. of the plants were left unsheltered, and, at the end of the season, these compared very well with the sheltered plants. Sheltering has now, therefore, been given up.

Briefly, it may be said that the best results are obtained by planting small teak seedlings as early in the rains as possible, on the patches where heaps of rubbish have been burnt. Such seedlings need very little attention thereafter. Seedlings planted on unburnt ground need weeding for two and sometimes for three

years, and they should be earthed up at the end of the rains, to counteract the scouring caused by the heavy rain. About 200 teak seedlings are planted per acre. Seeds of other species are sown with good results, and coppice comes up freely from the stools of the felled trees. Thirty standards are kept per acre. On the whole, the coupes worked during the last few years give promise of very good regeneration.

CONCENTRATED REGENERATION OF TEAK.

BY M. R. SUNDARAM AIYAR, EXTRA-ASSISTANT CONSERVATOR OF FORESTS.

Various experiments have been carried out in the past in India and Burma to get regeneration of teak with some sort of success, and the system, as adopted in the Burma forests under the Mohnyin working-plan, is, perhaps, the one best suited to teak.

The following notes deal with experiments carried out with some slight modification of the above system in the Tekkadi Leased Forest of the Anaimalais by the District Forest Officer, and it is interesting to note the results obtained therein.

The Tekkadi Leased Forests are too well known to require a detailed description, the general absence of teak poles being very conspicuous throughout the forests. Two experimental plots were laid out: one, near Mount Stuart (the head-quarters of the Tunacadavu Range); and the other, in the Ulandi valley; the former with a rainfall of 60 to 70 inches, and the latter over 100 inches.

Plot near Mount Stuart.—The plot measures 5½ acres in extent, and is laid out on a hillside with north-west aspect. The original crop consisted of a dense growth of bamboos (*Bambusa arundinacea*) with a few teak, rosewood (*Dalbergia latifolia*), Vengai (*Pterocarpus Marsupium*) and Karimarudu (*Terminalia tomentosa*) dotted about. The soil is a deep loam, well-drained, rich in humus, and highly suited to the growth of teak. The experiment was started with the idea of getting rid of bamboos, with a view to find out if any regeneration would come up. In

September 1914, all the bamboos over the area were cut, and left to dry, to be burned subsequently during the following hot weather. For some reason, burning was done only over a small portion of the area. With the setting-in of the south-west monsoon, the unburnt portion of the area became covered with a dense, impenetrable mass of weeds, lantana and débris from bamboo fellings. In December 1915, the burning of the area was again taken in hand and completed, and the area thus cleared was dibbled with teak seeds 6 feet apart, 3 seeds in one place. The seeds were put in just as they were collected from the forest without any special treatment. The places where the seeds were dibbled were marked by bamboo sticks, in order to locate seedlings and thereby to facilitate subsequent weedings. Dibbling was done between January and March 1916. The seeds germinated in May and ever since the area was kept weeded, the weeds being pulled up by the root.

It must be remembered that the trees left standing on the area were not felled. In open areas, the growth was excellent; while, under shade, the seedlings suffered much from drip. The plants are now six months old and, on an average, about 3 feet 6 inches in height. The tallest measures well over 5 feet.

The total cost of the experiment, exclusive of weedings, came to Rs. 33 per acre, which is very much higher than it ought to be; this was because all the regrowth of one monsoon had to be cut once again and burned. Four weedings have been done up to date, and no more are necessary. It is hoped that by careful and systematic working, these results may be obtained at a cost of Rs. 40 per acre.

Plot near Ulandi.—The plot is situated in the Ulandi valley about four miles from Mount Stuart. This valley is characterized by having a heavier rainfall and a denser crop of weeds than in the Tekkadi Leased Forest. The site for the plot was carefully selected to make sure of getting up teak, as judged by the existence of good sound teak trees all round it. The plot is considerably smaller in area, the object being to avoid cutting teak, rosewood and Vengai trees.

CONCENTRATED REGENERATION OF TEAK.

Fig. 1. Type of Natural Forest in the Anaimalais.
Teak trees over 18 feet in girth and about 140 feet in height.

Photo-Mechl. Dept., Thomason College Roorkee.

In this plot everything was cut out, bamboos being grubbed out by the root. No burning was done, all materials being removed out of the plot. The work was commenced in February and completed in March 1916. The area thus cleared was dibbled with teak seeds 3 feet apart, the seeds being put in as they were collected from the forest.

The seeds germinated in May 1916, when bamboo sticks were put in to locate their position and to facilitate weeding. Four weedings have been carried out up to date, weeds being pulled out by the root at every operation. The accompanying photograph (Fig. 2, Plate 9) was taken on the 10th November 1916. The plants are six months old and, on the average, well over 3 feet in height, the tallest measuring 5 feet. It will be seen from the photograph that no more weedings are necessary as the plants have closed up.

Photograph (Fig. 1, Plate 9) gives an idea of the type of forest in the Anaimalais and the size and height to which teak can grow there. The teak trees shown in the photograph are over 18 feet in girth, with an approximate height of 140 feet, and in a perfectly healthy condition.

The Tekkadi Forests get the full benefit of the south-west and north-east monsoons. The former commences in April and continues till September, while the latter begins in November and continues till January. The conditions are, therefore, very favourable for the production of teak ; and regeneration, once given a fair start, can thrive without any danger of dying back during the following short period of hot weather, *viz.*, from January to March.

EXTRACTS.

WOOD DISTILLATES.

It is estimated by the New York State College of Forestry that over 640 cords of beech, birch and maple wood are used every day in the wood distillation industry in New York State. The industry has been greatly stimulated by the European war, inasmuch as acetate of lime, one of the principal products of the industry, is used in the manufacture of high explosives. The price of wood alcohol, another product of the industry, has also risen very largely as a result of the war.—[*Scientific American.*]

[NOTE.—1 cord = 128 c.ft.]

PROTECTING A RARE PLANT IN SOUTH-WEST AFRICA.

The British administration in South-West Africa is keeping up the miniature park formerly maintained by the German government in the vicinity of Welwitsch, on the Windhuk line, for the preservation of the interesting plant *Welwitschia.* This plant, which bears only two leaves throughout its existence and grows for a century or more, is rare and of limited distribution. It is especially interesting from an ecological point of view, on account of its perfect adaptation to life in the desert belt where it is found. It was named in honour of Dr. F. Welwitsch, who discovered it in 1865.—[*Scientific American.*]

EFFECTS OF OAKS ON OLIVE TREES.

It is a well-known fact that olive trees are generally stunted in their growth when in the vicinity of oak woods. This phenomenon has been investigated in Italy by L. Petri, who made a series of pot cultures in which young olive and oak plants were grown a few inches apart. The net result of his experiments is that the failure of olive trees near oaks is due to the impoverishment of the soil by the latter, rather than by the transmission of any species of infection.—[*Scientific American.*]

I could illustrate my point of the danger which might arise from relying too much on standardized definitions, by relating in detail the method a cleaning was once carried out by three Imperial Forest Service Probationers in Germany, after a certain Forstmeister had given them a good general definition of cleanings, but I fear it would use up all my available paper.

Had the present feeling of hate existed at the time, I tremble to think of the "Straffing" the three students would have received for their efforts.

It is possible that the volume I have mentioned may not contain a definition of Improvement Fellings. If so, I fully sympathize with the author. The term is certainly somewhat ambiguous. I have personally only had experience of one division, in which such fellings are carried out, and there they formed the system under which the forests were worked, and not a subsidiary operation, as is the case of cleanings and thinnings.

In this case, the most suitable definition would be "a Stop Gap System for a forest, for which no more elaborate system of working could be prescribed." I do not, however, suggest the adoption of this as a standard definition.

Out of pity for the censor, I will not attempt to add to the number of definitions already published in your paper. Were I to do so, he might misinterpret them for some obscure form of code, and erase the principal points of them in consequence.

MESOPOTAMIA:
8th December 1916.

C. B. PATTERSON,
I.F.S.

VOLUME XLIII NUMBER 5

INDIAN FORESTER

MAY, 1917.

ORGANIZATION AND ACTIVITIES OF THE CHINESE FOREST SERVICE.

BY FORSYTHE SHERFESEE, ADVISER IN FORESTRY.

Almost simultaneously with the establishment of the Republic, there became manifest a growing recognition of the importance of forestry, of the severe loss along many lines from which China has suffered and must continue to suffer, due to the wholesale deforestation which took place centuries ago, and of the need for taking active steps to remedy the situation. The first result was shown when Mr. Chang Chien was Minister of Agriculture and Commerce, for, under his administration, certain progressive forest laws were promulgated. Nevertheless, it is proper to consider that forestry in China, as an aggressive national activity and in the sense in which the word is understood in Western countries, had its first real beginning with the inauguration in January 1916 of the Chinese Forest Service in the Ministry of Agriculture and Commerce. Mr. Chow-Tzu-chi, recently Minister of Agriculture and

Commerce, must be given principal credit for taking a step which, unless unforeseen contingencies occur to prevent, or unless future obstacles are placed in the way, cannot fail to have an extraordinarily wide and permanent effect upon the welfare of the Chinese people from very many points of view. It was due to his foresight, patriotism and frank recognition of what was necessary to meet an admitted economic need, that the Forest Service owes its existence. As Minister of Agriculture and Commerce, he submitted on December 22nd, 1915, a memorial to the President requesting authorization to organize a "National Forest Service" in the Ministry; and a favourable reply was promulgated on January 3rd, 1916. The Forest Service thus created was entrusted with the supervision or execution of all governmental work in forestry and with the encouragement of private enterprise along similar lines. At the head of the Service is the Minister of Agriculture and Commerce. The Vice-Minister is *ex-officio* Director-General. The Adviser in Forestry also acts as one of the two co-Directors, the other being a Chinese (Mr. Ngan Han), who had obtained technical education in forestry in the United States. There are several other technically trained Chinese in the Service, as well as an English expert (Mr. William Purdom), who serves as the chief of one of the six divisions into which the Service is organized.

GENERAL POLICY.

The general policy which the Forest Service has adopted may be expressed as follows:—

1. To lessen the present scarcity and high price of timber, fuel and other forest products of all kinds, by the judicious reforestation of public lands unfit for agriculture and now lying wholly or partially idle: thereby lessening the industrial handicap under which the Chinese manufacturer, farmer and householder labour at present, and increasing the comfort and raising the standard of living among all classes, particularly the middle class and the poor.

2. To regulate stream-flow, by the reforestation of the more important river-sheds or catchment areas, thus tending to prevent

floods, droughts, and the silting up of river bottoms with a consequent obstruction to navigation, and the frequent bursting of dykes, the construction of which in the first place was caused largely, if not wholly, by the deposits of silt washed down from the deforested slopes.

3. To protect, by technical forestry management, involving wise use, such public forest resources as still exist.

4. To encourage similar activities, by private parties, by demonstrating that forestry in China is an attractive financial investment, and by supplying needed advice and practical assistance.

5. To conduct a vigorous pro-forestry propaganda throughout China, showing, to all classes of people, the present national need for forestry; what deforestation and reforestation mean individually to the people; and the steps which the Government is taking and proposes to take, to better the situation.

6. To train up a corps of young Chinese to carry on the various lines of forestry work in China, and to encourage and, if possible, to assist in the giving of similar instruction in the educational institutions already established.

Although the general control of the activities of the Forest Service were immediately centred in the office of the Director-General, working under the approval of the Minister and through the two co-Directors, a further and more specialized organization into divisions soon became urgently called for, in order to insure that all of the various activities, which the Forest Service must or should perform, would be carried out with the highest possible degree of efficiency, economy and harmony. It is evident, of course, that without such a clearly defined segregation of duties or responsibilities there must inevitably be more or less duplication of work and loss of efficiency, and, what is equally important, the Service would fail to secure the benefits which result from training its new personnel, to become real experts in the particular branch of forestry for which, by inclination and ability, they are best fitted. Thus in February, 1916, the Minister approved the creation of six divisions: namely, the Division of Investigation, of Reforestation, of Propaganda, of Education, the Provincial Division

and the Clerical Division. It is also planned to appoint a Forest Commissioner in each province, who, with a staff of assistants, will encourage and supervise forestry work of all kinds within his respective jurisdiction. Each of these divisions will be taken up separately.

DIVISION OF INVESTIGATION.

The work of this division must lie at the very base of all sound and effective forest work in China. Without the sound, reliable data which may be expected to result from its activities, individual projects would have to be decided upon, and carried out in a more or less haphazard, experimental manner; for it must be kept constantly in mind that forestry in China is distinctly new, and that, although along general lines it is reasonable to suppose that methods which have been found most suitable in other and rather similar countries can be applied here, nevertheless the peculiar conditions of soil, climate and especially what we may call sociological conditions make it absolutely necessary that any methods imported from abroad should undergo more or less radical adaptation before success can be expected in China; and, in many cases even at first, it will probably be necessary for us to work along original lines. Thus, before we can be in a position to take up with confidence and to carry on successfully, economically and efficiently any extensive scheme of reforestation, we must have a fairly solid ground-work, based on a sure and reasonably complete knowledge of the climate, soil and other conditions under which we propose to work; of the species of trees, both native and foreign, which are suitable for use in the particular areas under consideration; of their silvicultural characteristics, rate of growth, economic importance, etc.; of whence their seeds can be obtained; of what has been learned from former experience with their use in China; and many more points along similar lines. In these studies, particular attention will be given to the native species, both because, in general, less is known about them, and because, in all probability, they are best suited for our use, due to their proven adaptability to the conditions under which we will have to work, and to the comparative cheapness and ease with which their seed

can be obtained. Very probably much of the needed data have already been collected by various persons—private botanists, travellers, missionaries, teachers in various colleges throughout China, members of this or other Bureaus or Ministries, etc., but the results of all such studies are more or less useless for our purpose until they have been collected and correlated, and so made available. Obviously, also, such information is necessary before we can be in a proper position to train new personnel.

It was to accomplish these duties that the Division of Investigation was organized. It has proceeded actively with its work and already a considerable amount of most useful data has been made available.

Reforestation Division.

This, at present, is the executive branch of the Forest Service, responsible for the economical and successful carrying out of all reforestation projects, including the establishment and care of nurseries, collection of seeds in large quantities, shipment of seeds and plants, transplanting to permanent locations in the hills, etc. It is the work of this division which will attract most public attention ; and, in many ways, it is the climax of all of the other activities of the Forest Service, at least until it becomes possible to place existing forests under technical forest management. This will be referred to later on in this article. For the present, at least, all of the other divisions will be indirectly but largely engaged in helping to make it possible for the Reforestation Division to do its work on a large scale, successfully and economically. The success of the Forest Service will, as it should, be judged largely by the success of this division ; and, therefore, too much care cannot be spent in supplying it with a scientifically sound ground-work (the work of the Division of Investigation), and in assigning to it the best possible personnel, wherever such personnel can be secured. It would be a fatal mistake to regard each reforestation project as distinct and separate in itself. They must be all grouped in one division under a single chief, who, under the Director-General of the Forest Service and the two co-Directors, will be responsible for the success or failure of them all. Otherwise, unnecessary and

undesirable duplication of experimental work will be sure to result the same failures will continue to be made in each project, and what is learned in one place will not readily be available for other projects. Only thus shall we be enabled to make the widest and most practicable use of the knowledge we gain from our failures and our successes. Moreover, by having all such projects directly under the constant supervision of a single chief of division, it will often be possible to assign to an individual project a man of lower calibre than would otherwise be possible (a very important consideration at this time when trained personnel is so scarce) who, while competent to give satisfactory service under some one else's supervision, would be unsuitable to take charge of more independent work. As soon as opportunity permits—and the time has not yet come—we will secure, either by direct appointment or by training, men competent to act as "inspecting forest nurserymen" or "supervising forest nurserymen"—men who are thoroughly familiar with all the details of the most modern nursery practice (having gained such familiarity, not merely from theory, but from actually doing the work themselves) and who, under the supervision of the Divisional chief, will spend all or most of their time in visiting the various projects, reporting to the central office on the results achieved in each place in proportion to cost, etc.; as well as on the relative ability of the various local personnel; correcting mistakes before they have been carried too far; giving advice for improvement wherever it is possible; keeping the man in charge of each project in touch with what has recently been learned in other projects, etc., etc. Such work and such a corps of men are of fundamental importance; in fact, it is impossible to see how satisfactory results can be accomplished without them, although at the present time such men in the Forest Service are very few and the difficulties in the way of securing others seem, just at present, so great as to be well-nigh insuperable.

PROVINCIAL DIVISION.

This division has supervision over all forestry work carried out by, or in, the various provinces, except in the case of those

projects (such as forest nurseries) directly established and maintained by the Forest Service itself. To the chief of this division there will be referred, through the Director-General and the co-Directors, all correspondence received from the Provincial Forest Commissioners, and from any provincial forestry bureaus ; and he will prepare, for the signature of the proper official, whatever instructions or suggestions it may be desired to send to the provincial authorities. He is expected to keep thoroughly informed, at all times, of the progress made in forestry in each of the provinces, and he will maintain a constant correspondence with all Provincial Forest Commissioners, acknowledging and commenting upon their monthly reports, making suggestions, offering criticisms, keeping them informed of the progress made in other provinces, etc. He will know how the forest funds of each province are being spent, and he will compare such expenditure with the results obtained. When called upon, he will be able to give a reliable, frank opinion in regard to the faithfulness and ability of each Provincial Forest Commissioner, and of his technical assistant or assistants, if any.

The success of the Provincial Forest Commissioner organization will largely depend upon the chief of this division. If left to themselves, it may be expected that, in most cases, there will be but little work or only perfunctory work. Without constant prodding and stimulation, the provincial organizations will soon become moribund, and the money spent for their upkeep will be largely or wholly wasted. Even if individual Forest Commissioners are willing to work, they have to be told what to do, not only once, but repeatedly, slowly and patiently trained to their duties. The best Forest Commissioners must be shown that their work is known and appreciated ; and the poorer ones must be given to understand that the Ministry is not unaware of their failure. It is, of course, desirable that each Forest Commissioner should have received technical training in forestry, but at present, and for a long time to come, this will be possible of realization only in a comparatively few cases. The best that we can hope for is to secure a Forest Commissioner who is actively interested in the

promotion of forestry in his province, who appreciates its importance, and who has the influence, energy and ability to impress such views upon the people at large. We hope to be able to supply most, if not all, of such Forest Commissioners with one or more assistants who have received some technical training. We also plan to maintain a corps of trained assistants to travel from province to province, inspecting and reporting upon the work and attitude of the Forest Commissioner in each.

In discussing this division, I have, of necessity, often used the future tense; for, up to the present time, its organization on paper has not been fully translated into actual practice. Obviously, the chiefship of this division demands qualities of a very special type, the possessor of which is very difficult to obtain; and, for the present, although seriously interfering with his other duties, the work has cheerfully been taken over by the Chinese co-Director of the Service. He should, however, be relieved as promptly as possible, in order that his full time and energies may be devoted to the broader work implied by his position.

PROPAGANDA DIVISION.

The importance of an active, energetic, intelligent pro-forestry propaganda can hardly be over-estimated. Such a campaign will be conducted with the objects, first, of bringing all classes of people to realize the benefits of a governmental forest policy not only to the country in general, but to each individual in particular; and, in the second place, to make clearly understood what should be done and the steps which the Government is taking to do it. In this way, not only will the Forest Service secure the needed sympathy and support, but the people will appreciate the work which the Central Government is doing for their benefit. The success of such a propaganda will mean that the forestry movement will be a popular one, receiving its support from the great mass of the people rather than remain, as it is now, a purely official undertaking. Only thus can it be placed upon a firm, permanent basis, or obtain the means for wide expansion. The

campaign will be directed towards all classes, the high official class no less than the small merchant class or the peasant farmer; in fact, rather more so, for just as in the United States fifteen years ago the number of even highly cultured and educated citizens who had more than an elementary knowledge of what forestry really is, was decidedly limited, so here in China we must begin at the top, with the educated class and with the officials, as well as in the middle and at the bottom. All classes can be reached. It is merely a question of adopting different media and different methods. Among the most convenient and efficient instruments for use in such a propaganda are:—

1. *Newspapers, magazines and other periodicals.*—The field, which these reach, is obviously limited, but it is an extremely important one, including the influential officials, the educated classes and most, if not all, persons of wide influence and authority. Moreover, it affords the easiest, quickest and cheapest means of communication. The editors of most newspapers and magazines are glad to publish any article on forestry in any of its branches, which is fairly well thought out and fairly well expressed, and thus we have an opportunity to present our facts and our arguments directly to a select and important audience. It is also desirable that the forestry work of the Government should be called *constantly* to the attention of the public; and, therefore, in addition to the longer articles it is important to see that the daily newspapers receive "personal" items about the members of the Forest Service, such as their arrivals from official trips, their departure for work in the provinces, transfers, promotions, new projects, etc., anything that brings the name of the Forest Service repeatedly before the readers' attention. Our ideal should be that every day the principal newspapers should somewhere contain some reference to the Forest Service, its work, actual or proposed, or its personnel. Such "advertising," if intelligently conducted in good faith, can be made of very great assistance.

2. *Printed papers, circulars, etc.*—The field which these reach is obviously larger than that covered by newspapers and other periodicals, and they will be used as extensively as monetary

considerations permit. As their readers are, generally speaking, less highly educated than those of bought periodicals, the subject-matter will be prepared in a simpler, more popular style. Such circulars will be distributed throughout the various provinces, securely pasted to permanent sites where they will attract widest attention, and in all other practicable means brought to the notice of the people.

3. *Lectures and informal talks.*—Although newspapers, circulars, etc., are extremely important and should, on no account, be neglected, the fact remains that millions of people must be reached verbally, if at all. For these, lectures and informal talks are the only available means, or at least the principal ones.

Whenever possible, the lectures will be illustrated by lantern-slides, or otherwise made more superficially attractive. They will be prepared for the educated classes, for teachers, for students and for the public in general as well as for that portion of the public who are illiterate. The schools present a very attractive field for this class of work, and special effort will be made to interest and instruct the teachers in the importance of forestry, in order that they may impart a similar impression to the students of each succeeding class. Such work can generally be easily arranged and can be carried on at but slight expense.

We will also take steps to interest all schools—public, private, and missionary—in forestry, and induce them to include something about forestry in their course of study, not with the idea of training up foresters or forest employees of any kind, but merely to impress upon the general student-body what forestry is, what it means to the country, and what the Central Government is doing to foster it. This I regard as very important. If we neglect it, we are throwing away an opportunity of great possibilities. We hope that an elementary or primary text-book on forestry can be prepared, popularly written and attractively illustrated, printed at the Government's expense (in large, cheap editions) and sent gratis or at cost price to all the schools. Opportunity will frequently be made for the higher officials of the Forest Service to address the student-bodies of the various universities, learned societies, etc. All of

these activities are perfectly feasible and practicable, and the resulting benefits are sure, provided that there is an adequate personnel for carrying them on.

Informal talks will be given before the poorer and more ignorant people of the towns and villages by the various travelling members of the Forest Service, by the Provincial Forest Commissioners and their assistants, and by influential men of the locality who may become sufficiently interested in our work. The tea-shops present an excellent location for such talks, or else the local officials can arrange places for larger and more formal meetings. In such talks the audience should be encouraged to ask questions, and, in other ways, to take an active interest in what is being said. Such informal meetings, or "talks" (in fact all the methods here mentioned), have proved surprisingly popular and effective in the Philippines, and I see no reason to suppose that we will not meet with proportionate success here.

No matter how strongly and firmly the forest policy may be upheld and enforced by the Central Government (and this applies to all countries as well as to China), it can be made really effective in the highest sense only with the co-operation of the people; and, without such popular sympathy and support, the forester's opportunities for good, however skilful he may be, and however correct his policies, are severely limited—the merest fraction of what they can be made to be under more favourable circumstances. I do not, I hope, under-estimate the difficulties; I am convinced that I do not over-estimate the importance, especially here, where one of our greatest problems is concerned with protection from fuel gatherers and from theft. Without popular co-operation this difficulty, at least, seems well-nigh insurmountable. In the Philippines, we had much the same situation although, obviously, on a very much smaller scale; and there it was necessary to reach the wild tribes of certain mountain regions no less than the civilized Filipinos of the plains: but the desired results were accomplished, and the attitude of the great body of forest users and forest dwellers was changed from active or passive resistance to at least passive

acceptance of the new conditions. Among the practical and almost immediate effects were a clearly appreciable increase in the collection of just forest dues, a decrease in violations (especially those due to ignorance), and a very notable change for the better in the attitude of the Filipino Assembly. I feel, therefore, that in emphasizing the importance and practicability of an active pro-forestry propaganda I am not indulging in mere hypothesis. The remarkable propaganda undertaken by the United States Forest Service some years ago, and its even more remarkable results, are well known to all foresters.

DIVISION OF EDUCATION.

The greatest, the most pressing need of the Chinese Forest Service at the present time is an adequate and properly equipped personnel; and, as it is obviously impossible to secure the desired number of men, who have already been properly trained both technically and in the school of practical experience, our only recourse is to train ourselves the men we need for the secondary or ranger grades or at least to have them trained under our supervision in independent educational institutions. It is not a task that can be left wholly, or even largely, to others. The permanent success of the Forest Service will largely depend upon the training, and especially upon the attitude which the forestry students acquire during their studies, and hence their education is of such vital importance to the cause of Chinese forestry that it cannot be wholly entrusted to any other body, even if there were an institution able and willing to give it. There are a few institutions, and especially the University of Nanking, which is making a strong and most praiseworthy effort to train up the kind of men needed for forest work in China; but, unfortunately, the funds and especially the staff of instructors are severely limited.

For the immediate present, we are not in a position to concern ourselves with higher technical forestry education. We recognize the importance, or rather the necessity, of maintaining always a moderate-sized corps of highly-trained technical foresters, but it

is wholly impracticable to attempt to give such training here and now. In the first place, we neither have, nor can obtain, the instructors, the buildings or the equipment; and, in the second place, the cost would be high, out of all proportion to the number of graduates. For several years to come, it will be necessary to adopt the far more economical course of obtaining the highly trained foresters we need from among the graduates of forest schools abroad (sending thereto properly prepared young Chinese under government scholarships), rather than to attempt to educate them here. In time, of course, this situation will change, and we should look forward eventually—soon, I hope—to seeing forestry education given in all its branches in China; but that need not concern us now.

CLERICAL DIVISION.

This division, as its name implies, has charge of all clerical work in the central office of the Forest Service,—copyists, translators, typists, clerks, labourers and non-technical personnel of all kinds.

. . . .

So much for the activities of the six divisions into which the Forest Service has now been organized. Later on, as the personnel of the Service increases, as more funds become available, and when, as a natural consequence, the scope of its activities enlarges, we hope that two other lines of work will attain sufficient importance to justify their recognition in the divisional organization. Such may be called, tentatively, the proposed Division of Forest Management and the proposed Division of Co-operation.

The Division of Forest Management, if it should be established, will concern itself with the administration, by conservative technical methods of forestry, of existing public timber lands—not in any way prohibiting their use, or unduly restricting the profit which may be obtained therefrom for the present generation of Chinese. *We certainly would not wish to create national forest* "reserves" in the sense that "reserve" means—the locking up of such resources for the benefit of future generations. The forester

does not believe in prohibition of use but in wise conservative utilization, so that the forest resources will be made to yield the greatest possible benefit to the present inhabitants of the country, but without decreasing their productive capacity or their potential benefits to the generations to come. The forester never forgets that the people come first; that forestry is not an end in itself but a means, although a very essential means, to increasing the welfare of the people at large. This thought is expressed admirably in a book, recently issued by Mr. Pinchot, former Chief of the United States Forest Service, and the man to whom, more than to any other, America owes its present forest policy. In the opening paragraph he asks frankly "What is Forestry?" and he answers as follows :—

"Forestry is the knowledge of the forest. In particular, it is the art of handling the forest so that it will render whatever service is required of it without being impoverished or destroyed. For example, a forest may be handled so as to produce saw logs, telegraph poles, barrel hoops, firewood, tan bark, or turpentine. The main purpose of its treatment may be to prevent the washing of soil, to regulate the flow of streams, to support cattle or sheep, or it may be handled so as to supply a wide range and combination of uses. *Forestry is the art of producing from the forest whatever it can yield for the service of man.*"

While, as I have said above, speaking in general terms, forestry in China will be popularly judged by our success or lack of success in reforestation, the management of existing forest areas (which possess a value all the greater by reason of their scarcity) is too important to be neglected, and the Forest Service anxiously longs for the day when such timber lands can be put under technical administration.

The part that the proposed Division of Co-operation will undoubtedly play in the future is very large. As soon as we are in a position to give definite advice as to all-important details of reforestation on a large scale (and we, in the Forest Service, are the first to recognize that we shall not be in such a position until much investigative and experimental work has been done, adapting

general theory to the particular conditions of the locality), there is reason to expect that co-operation can be secured from railroad companies, mining companies, universities, corporations, institutions and private individuals who possess areas of land now lying more or less idle and unproductive. If we can tell, then, exactly what should be done, what it will cost and just what results may reasonably be expected; and if, in addition, we can offer to oversee at least the inauguration of the work, and possibly to keep general supervision over it for a term of years, we can, in all probability, bring about a wide extension of reforestation at little or no cost to the Central Government. The work to be done is too enormous to depend upon the Government alone. The ultimate success of the Forest Service will depend upon its success or failure in inducing private enterprise to take up the work it advocates. Moreover, private forestry enterprise, once its financial success is demonstrated, will increase at an ever-growing rate of speed. It will far outstrip anything the Government can do. It is much more apt to be imitated than forestry carried on by the Government, for although we may constantly preach that forestry is an attractive financial investment, we must be able to point to definite results to prove our assertions. It is self-evident that forestry, if continued by private enterprise, must be profitable or else it would not be extended. This opportunity is far too important to be neglected. Most co-operators will naturally regard the project merely as a business proposition, as a matter of dollars and cents, and we should not attempt such work until we have the solid ground-work of first-hand experience to stand on. An initial failure would be even more infectious than an initial success.

While the exact terms of co-operation may well vary with each project, in general, it is only fair to have the co-operator pay all expenses for seeds, trees and labour, or even in some cases even the salary of the member or members detailed to the project may be included. In other cases, and especially when dealing with schools, universities and other institutions of a more or less philanthropic character, the Government may supply free the technical advice and supervision, leaving merely the other expenses to be borne by the co-operator.

APPROPRIATIONS.

At the present time, the appropriations for the support of the Forest Service are made directly by the Central Government, through the Ministry of Agriculture and Commerce ; and, so far as can be foreseen, this will, for some time, continue to be our main source of revenue. There are two or three other sources, however, from which additional funds can be secured. First (of comparatively less importance) from co-operators, as discussed above ; and second, from provinces by appropriations for the maintenance of the Forest Commissioners with their respective staffs. This was provided for by presidential mandate at about the time the Forest Service was created, but up to the present time conditions have been too disturbed to permit its more than partial realization. A third source of revenue is, in my opinion, of much potential importance. There is a strong popular demand for young trees suitable for transplanting—a demand from owners of private estates, from railroad companies, from the provinces themselves and from various other sources ; and this demand could easily be very largely increased. So far as possible, therefore, in establishing forest nurseries throughout the provinces, we will endeavour to maintain them on a scale more than adequate for our own needs, disposing of the surplus stock at a price low in comparison with what would have to be paid if the Government nursery had not been established, but sufficient to enable us thereby to meet part, if not all, of the expenses of the entire nursery. As I have said above, forestry in China may be regarded as an attractive business proposition, and its returns should begin to come in within a surprisingly short time. They can, in fact, be made to begin within two or three years after the nursery is first established. I do not mean in any way to imply that prices for nursery stock would be fixed at a point which would, in the slightest, discourage its purchase and use. The main object should be accomplished, even if it should entail a continuous financial expenditure without direct monetary returns ; but, if the object for which the Forest Service exists can be accomplished more cheaply, it is not only our right but our very distinct duty to the Chinese tax-payers, to conduct our activities at the lowest

possible cost. The money at our disposal will always be severely limited in comparison with the task imposed upon us. A saving here, or the making of a profit there, means that there will be just so much more available for opening up needed projects elsewhere. And again, the demonstration by the Government of the financial profits which can be made from forestry in China, will be decidedly our most telling argument. If we cannot put forestry in China on a financially profitable basis, our work is doomed at the outset to severe limitation; but I am convinced that it is distinctly practicable and that it will be our own fault if we fail.

MINOR ACTIVITIES.

In the paragraphs above, I have discussed the main lines along which our work will probably lie. There are other problems which I would have liked to discuss, especially, that which has to do with protection, but the article has already become of undue length. Certain minor activities, however, which have been already undertaken and are now in full swing may be mentioned. Among these are the translation into Chinese of elementary but thorough text and reference books on forestry; for, up to the present time, forestry literature in Chinese is almost, if not quite, non-existent; the preparation of an English-Chinese Glossary of Technical Terms Used in Forestry, in order that such practice may be kept uniform; the preparation of a Check List (or Dictionary) of Chinese Forest Trees, with their botanical and local names their habitat, etc.; the beginning of a Forest Map of China, an unending task but none the less necessary; the collection of wood specimens, of a forest herbarium, of minor forest products, etc. All such work, while perhaps from one point of view of minor importance, has, in the aggregate, a very great influence in helping the Forest Service to accomplish the task it has been set to do; *viz.*, so to manage and increase the forest resources of the country as to improve the comfort, prosperity and well-being of its inhabitants, present and to come.

A START IN THE DEPARTMENTAL SUPPLY OF RUBBER BOXES IN MERGUI.

BY A. B. NIXON, I.F.S.

1. A few remarks about the departmental supply of boxes to various rubber estates in the Mergui district (South Tenasserim Division) may be of interest.

The idea was mooted in 1915. Estates, with the exception of one which uses the very expensive Venesta boxes, were not only finding increasing difficulty in procuring Japanese boxes, but these were steadily becoming of worse quality. As the planks are often joined by bamboo pegs, the boxes come to grief before reaching the wharf.

The initial difficulty was how to convert into tongue-and-groove planks. Most respectable places have two or three saw-mills, but Mergui, though a port, boasts of but one, and that unreliable in machinery and management. There was no tongue-and-groove plant, but after much pressure and much delay, an old plant was repaired and put in order by January 1916.

2. Previously I had experimented with hand-made boxes of various woods including Mango (Mangifera indica), *Didu* (Bombax insigne), *Kywethwai* (Myristica Irya ?), *Myauk-kaung* (Artocarpus calophylla ?) and various unidentified woods, but as rubber has to be packed under great pressure, they were useless. Then I tried *Yemane* (Gmelina arborea), which is fairly close-grained and fairly hard, and takes nails excellently, and directly the mill machinery was working, I had 20 tongue-and-groove boxes turned out and supplied as samples. These were favourably received, and though made of green wood which warped slightly, a few sent to England arrived in good condition.

Having settled on *Yemane*, 750 tons were extracted departmentally last rains.

3. A word about the *Yemane* forests which are interesting. There are two or three species apparently and specimens are now being collected. One haunts the shores of the Archipelago islands (the *pinle-yemane*), one haunts the higher hills (the *taung-yemane*), but the one exploited for boxes I will call the flood-*yemane*. It

occurs chiefly up the Little Tenasserim River, above its junction with the Big Tenasserim River. There is a stretch of nearly flat country, averaging three miles in width from the banks, between them and the hills, and as yet of unknown extent.

This forest, which is stocked to varying degrees with *yemane*, is annually flooded in the rains for two or three periods of two or three weeks each, to a depth of 5 feet to 7 feet. A thick silt is deposited on all vegetation up to this height when the water finally subsides.

The floods are caused by the high waters of the Big Tenasserim River, which bank up those of its main tributary and prevent the waters escaping through the gorges below their junction. Extraction is, therefore, of the easiest. The logs are dragged by boats from the felling site to the main stream.

An interesting point now being investigated is how *yemane* regenerates under these conditions, as the ground is completely submerged for such a long period.

4. Some people may think *yemane* too good a wood for boxes, yet it has no other use here and is plentiful. It is on the heavy side for boxes, but freight is by bulk so this is of no consequence.

5. The following figures may be of some interest, but they will shortly be modified, as the cost of extraction under subsequent departmental contracts will be less, and the conversion charges at present owing to local conditions are absurdly high :—

One ton of conversions averages 53 boxes, 24" × 21" × 20".

	Rs.	a.	p.
Cost of extraction from forest to Mergui, per box	0	4	6
Cost of conversion from forest to Mergui, per box	0	11	9
Cost of carpenter hire from forest to Mergui, per box	0	0	5
Total cost per box	1	0	8
Sale price per box	1	4	0
Profit per box	0	3	4

There are no other expenses except initial cost of godown and workshop, *i.e.*, Rs. 625. No extra staff is required.

Royalty (Re. 1-8-0 per ton) is not considered in these calculations.

6. The local demand was estimated at about 1,000 boxes a month, rising next year. Though the boxes have only been on the market since November last, 550 a month were on monthly order at once.

The stock size is cheapest of conversion, as only one width of plank is required, *i.e.*, 5 inches, but other sizes can be supplied.

Stock to produce 15,900 boxes is now in hand.

7. This small beginning, up to 1,000 a month, is all that can be attemped under present conditions of conversion and freight.

Steps are now being taken with a view to setting up a departmental saw-mill, solely to convert into boxes for rubber and tea. When, and if, this takes place, the department can undertake to supply not only other parts of Burma, but the Straits and Ceylon, which are hard up for rubber boxes now.

8. A point to watch after the war is the rival Venesta box, which cannot be produced except under expert direction, but if Japanese boxes hold their own, I maintain that Burma made ones have an equal or greater chance. Either a departmental saw-mill or an enterprising private saw-mill, devoted solely to the purpose, could turn out in Mergui tongue-and-groove boxes at 12 annas each on a large scale.

This is probably not attainable till after the war, as though Mergui district, largely unexplored, is one mass of evergreen forests, with easy water extraction, of an unlimited number of species suitable for all forms of box-making, yet, with the one little paddle-steamer, which is now allowed to visit the port weekly, it is practically cut off from the commercial world for the time being, except for the export of necessities like wolfram and rubber.

SAL AT ITS EXTREME EASTERN LIMIT.

BY B. C. SEN GUPTA, PROVINCIAL FOREST SERVICE.

The total area of Sal in the Darrang Forest Division in Assam is very small, being only about 700 acres, but the forests are interesting to the Forester owing to their situation at the eastern-most limit of Sal. Another cause of their importance is that the climate of Assam is so damp that Sal is the only local wood which lasts for some time in contact with earth. So, in spite of their smallness, these forests are well worth careful attention.

The Sal here is found in small isolated patches, the largest of which is only about 550 acres in extent. The areas which contain Sal are as follows :—

Balipara Reserve	...	...	583 acres.
Gorumari ...	...	...	50 „
Singri Hill ...	...	...	50 „
	Total	...	683 acres.

The ground is level except in the last-named Reserve. The forests were reserved in 1874, 1875 and in 1878 respectively, *i.e.*, about 40 years ago. For more than 40 years, uncontrolled felling has been stopped, and these forests have been worked under a regular plan for ten years, on a short rotation of five years. Fire-protection has been in force ever since the reservation was completed, and it has been most successful in the Balipara Reserve where no fire occurred since 1877-78 except on two occasions, *viz.*, in 1903-04 and in 1908-09 when 48 and 169 acres respectively were burnt. There were occasional petty fires in the Gorumari Reserve, while Singri Hill was subject to fires even up to recent date. The forests are closed to grazing.

It would be interesting to know how far the forests have benefited from this protection and by the improvement fellings.

The effects have not been uniform, so the three reserves are dealt with separately.

BALIPARA RESERVE.

Though all classes of trees are well represented, and in due proportion, they are not well distributed, and the old stock of crooked and malformed trees has not yet been replaced by straight, clean-boled sound ones, while the new poles are very unevenly distributed, being entirely absent in some places and too congested in others. In the eastern part of one block undergrowth consisting of a dense mass of evergreen shrubs and herbs has made natural regeneration impossible. The local conditions here are such that it is very doubtful whether it will be possible to bring the forests into a normal condition, or even to such an improved state as will permit of their being worked under any other system than he method of "Clear felling and artificial regeneration," as recently suggested by Mr. Troup, when Silviculturist, and supported by the Inspector-General of Forests, for the Sal forests of the Dooars including Goalpara Division—(*vide* Inspector-General's notes on Sal forests in Jalpaiguri, Buxa and Goalpara Forest Divisions). Fire-protection, as in the Dooars, has greatly encouraged the growth of shrubs and undergrowth, and the further extension of Sal has been stopped except towards the Savannahs, which are also being rapidly occupied by *Eugenia operculata*...........one of the first species which come up in the grass-lands after struggling through annual fires. The forest has, to some extent, suffered from the necessity of cutting from it the timber for the construction of two bungalows, one large bridge and other small ones. Years ago, a number of efforts were made to introduce Sal into the Savannahs by both natural and artificial means, but the Sal proved most capricious and no success was achieved.

GORUMARI RESERVE.

This is the best piece of Sal forest in the whole district. Trees are straight and well-shaped, and all classes are well-represented and fairly well-distributed. Seedlings and advance growth are plentiful around the edges but not under the old crop. Sal is extending in all directions. The soil is not very damp, and there are not many trees of evergreen species, but there is a patch of

miscellaneous species towards the south. Trees are growing too close together, and a good number of them could be thinned out without unduly opening the canopy. A large proportion of the old stock and of the dominated trees should now be removed, and the blank towards the east should be regenerated artificially.

It is interesting to record that one of the Assam kings removed a number of very fine posts from this Reserve with the idea of bridging the Brahmaputra near Tezpur—a project to which the Sara bridge over the Ganges would be mere child's play. The posts were kept under water in a tank, and were found to be in good condition when dredged up and sold.

Singri Hill Reserve.

This Reserve comprises some 30 small hills and the Sal is situated on or near the tops of 7 or 8 of these, occupying only about 50 acres on the whole, and is now extending downwards on the slopes. The gradient is mostly very steep, and there is no demand for the timber for want of any means of extraction, and also on account of the crookedness of the trees. Consequently, no trees have been felled, or any other operation, except climber-cutting, undertaken since the preparation of the working-plan or, rather, since the reservation. The condition of the forest is, therefore, not good. The trees are mostly very crooked, though not on the whole unsound. On the top of the hills, where there is more room, the trees are of much better shape. Natural reproduction is, as usual in nearly all fire-protected Sal forests, insufficient, but in many places advance growth is plentiful. That the forest is capable of producing trees of good shape is evident from the quality of some of the existing stock. Fire-protection has done immense good to the crop and soil, and a thick layer of humus has been formed, while the undergrowth here is not too dense.

General.

The climatic conditions in Assam, for the growth of good Sal, are more and more unfavourable as we go towards the east,

and this is on the easternmost limit of Sal. The ground is level and low, and the soil remains damp during most part of the year. These factors combined make the locality a most suitable home for herbs and evergreen species, which come up on the slightest opening of the canopy, and choke any Sal seedlings which may happen to be among them. Anybody, who has carefully inspected the forests, will not fail to notice that, in all these forests, the Sal appears to be moving from its original site to wherever it finds the conditions more favourable. In the Balipara Reserve, it has succeeded in moving towards the south-west. On the original site, the ground has become too damp, and the dense undergrowth, which has now come up, has made it quite unfavourable for the natural regeneration of Sal. Here now remain only the refuse of the old stock with very few young trees. (See Plate No. 10.) Towards the east, the progress was stopped by a wall of evergreen species, which is growing in the adjacent low land; and towards the north-west, though it started well, it was again opposed by miscellaneous species. It succeeded best in the south-west direction where it formed a pure crop; but here also the shrubs and undergrowth, which were favoured by successful fire-protection, have stood in the way of further extension; on the other hand, masses of *Eugenia operculata* are occupying the Savannah lands in the opposite direction and will soon meet the Sal face to face. In Singri Hill Reserve, the Sal is moving from the tops along the southern slopes, but it has been checked by the other species near the foot. In Gorumari, it is moving in all directions into the Bata grasses which surround the Sal area.

It appears to be an established fact that Sal does not grow under the mother trees. It has a tendency to leave the old site and establish itself elsewhere, if the conditions are favourable. But the climatic conditions in this district are such that, without substantial help from man, Sal can extend no further. The ground, as stated above, is, except in Singri Hills, nearly flat, and the thick layer of humus formed, under long continued fire-protection, keeps it too damp for Sal; while, on the other hand, it is a most suitable habitat for the growth of evergreen species, which, in their turn, tend

Photo-Mechl. Dept., Thomason College, Roorkee.

Sal at its extreme eastern limit.

to keep the soil still more damp. This state of things attracted the attention of the authorities some time ago, and "Cleaning" operations were undertaken from 1912-13, and were continued for five years over the whole Sal area, but to no purpose. They gave temporary relief only for a few months, and, with the advent of the rains, the Sal relapsed into its former state. Thus, as in the Dooars and Goalpara forests, the attempt resulted in a waste of money.

It is now evident that a thick undergrowth will come up under the old crop, in spite of all efforts short of annual burning, after cutting and drying the undergrowth for a long period, which is too expensive and a great loss of time, and at the same time most harmful to the timber and soil. We are thus between Scylla and Charybdis, for fire-protection will gradually exterminate Sal, while non-protection will spoil the timber, retard the growth and do harm in many other ways; again, the congested clumps cannot be thinned or inferior species cleaned out to the extent desired, as it would result in a luxuriant undergrowth; while, without thinning and cleaning, the Sal poles and saplings are suppressed or become malformed. This ill-effect was foreseen by Mr. Coventry, the Working-Plans Officer, who remarked in the report with respect of block B.:

"Sal will probably soon disappear from most of the area as the soil has become too damp."

But, in justice to fire-protection, it must be admitted that it has much improved the state of the existing crop.

The simplest way to solve the problem, therefore, will be to take the two subjects in hand separately, *i.e.*, to preserve carefully what we have already, and regenerate by artificial means, as recommended by the Inspector-General of Forests. For this purpose, we should give more room to the existing trees, without paying any attention to natural regeneration, and remove as many malformed and unsound trees as we may, without opening the canopy so much as to encourage the development of epicormic branches. They will thus get more light and freely spread their branches; and, consequently, the growth in volume will be much stimulated, and we shall get the greatest quantity of material from the area in a given

time. When they attain maturity the area will be clear felled, which will be followed first by field cultivation, and then by artificial regeneration by direct sowing.

The writer who was asked to write reports on the Sal forests, on the expiry of the working-plan, proposed that the Sal forests of Darrang, except Singri Hill Reserve, should be treated under the new method devised by Mr. Troup, when Silviculturist, and supported by the Inspector-General of Forests, for the forests growing in a climate very similar to that of this district.

In Singri Hill, which remained practically untouched for more than half a century, and where the trees are mostly crooked and congested, field cultivation cannot be admitted, owing to the steepness of the slope, but the undergrowth here is not too dense, and simply cutting the inferior species and undergrowth and burning them will be quite sufficient on the slopes. Here the conditions are so favourable that regeneration will take place naturally if the slopes are cleared in the above manner. While, in the actual Sal area, the crooked trees will be removed, and the congested trees thinned out by repeated light improvement fellings, as often as the Divisional Forest Officer may think fit.

That artificial regeneration will be successful is evident from the appearance of the trees in the old plantation which are growing quite satisfactorily without any tending. Plate No. 11 gives a near view of the plantation. The trees are about 40 years old and the maximum height is about 100 feet.

COPPICE WITH STANDARDS.

BY A. WIMBUSH, I.F.S.

Having had the opportunity, in recent years, of seeing various forests worked under the Coppice-with-Standards method, both in Southern and Northern India, I have realized how different are the ways of marking the standards, and of exercising a check on the working of the coupes in different localities.

I think, therefore, that it may be of interest to describe, in some detail, a method of working that ensures the fulfilment of the

Photo-Mechl. Dept., Thomason College, Roorkee.

Sal at its extreme eastern limit.

purposes for which standards are marked, so far as it is possible for any method to do this.

It is first necessary to consider the objects to be aimed at; they are—

(1) To mark the trees in such a way that a felling cooly can see the mark at a glance.

(2) To mark the trees in such a way that no possible injury can result to the trees from the marking.

(3) To mark and record the trees in such a way that detection is certain if a marked tree is felled, provided the standards are checked.

(4) To mark and record trees on a system which will render both the marking, as regards the number of standards required per acre, and the checking of the standards after felling the other trees, as easy as possible.

(5) To devise a means of preventing more than a small proportion of the coupe being damaged silviculturally, in the event of a dishonest contractor felling marked trees.

(6) To mark and record trees in such a way as to be certain that the man, whose business it is to check the standards, shall make a complete and thorough check, and not merely satisfy himself that a certain definite number of trees are left standing in the coupe.

Dealing with the above objects in turn, an attempt will be made to show how each may best be attained:—

(1) A tar ring at breast-height should be made round each standard to be reserved.

(2) Hammer-marking the base of standards should be avoided, as being both unnecessary and injurious.

(3) A number in tar should be painted on each standard and the number, species and girth should be recorded in a standard register. The number should be put just above the tar ring, in order to avoid its being obliterated if the tar from the ring runs.

(4) In order to attain the fourth object, it is very desirable to divide the coupe into four or five strips ; and, in the case of large coupes, it may be even desirable to divide each strip into two or more "bits," by means of lines at right angles to the strip lines. Where possible, paths or ravines may be taken as strip lines ; but, if these do not exist, four feet lines straight through the undergrowth can be cut very cheaply and quickly. For a "bit" line, a width of two feet should suffice.

The reasons for these sub-divisions are—

(*a*) To enable the marking officer to keep a check on his work as regards the number of trees he is marking per acre. Ten minutes' work with the map will enable him to know, at any rate approximately, the area of each strip or "bit."

(*b*) To avoid the necessity of the serial numbers on the trees running into four or five figures, since a new series should be started for each strip or "bit."

(*c*) To enable the felling work to be confined to one strip at a time.

(*d*) To enable the checking officer to locate illicit felling of standards, should any occur.

5. The contractor's agreement should contain a clause to the effect that no work may be started in strip 2 until the standards in strip 1 have been checked, and his work passed as satisfactory ; and that, after strip 2 has been handed over to him, no further felling in strip 1 will be allowed.

From the silvicultural point of view, this arrangement is considered very important because a bad contractor cannot do very much damage before being pulled up short ; whereas, when no check is made until a whole coupe has been worked over, no amount of recovery from security deposits can give true satisfaction for the silvicultural damage.

6. From the fact of the number, species and girth of each standard being recorded in the standard register for each strip or "bit" separately, it follows that if the checking officer walks up

and down the coupe in the middle of a line of about four coolies or subordinates, and if the latter call out the number of each tree as they come to it, a glance at the register will suffice to satisfy the checking officer whether the numbered tree is the one actually marked originally, or whether an inferior tree has been ringed and numbered in its place.

Should any number in the register not have a tick against it at the completion of the checking, the officer can go straight to the place where the tree bearing that number ought to stand, and see whether it has been missed out by mistake, or whether it has been felled and removed.

In order that the above method may be intelligible to a contractor, he should be given a tracing of the map showing the strips clearly marked and numbered and, if possible, he should be shown the strip lines on the ground also.

It may be considered that this method would involve too much attention to detail and take too long to carry out for it to be of practical value. It has, however, been carried out with complete success for many years in the Tinnevelly District of Madras and, from personal experience in checking standards with a class of ranger students, in a coupe which we had not marked ourselves, and of which we were simply given the standard register and the help of the local forest guard, I can assure those who doubt its efficacy that it is, by no means, as difficult to work in practice as it may appear to be on paper.

A GROWL OR TWO FROM BURMA.

BY NGADAUK.

Will the *Indian Forester* allow me to get a few things off my chest.

Conferences.—In Burma, it has now become the established custom to hold a Conservator's Conference every year in June. Except for the fact that the proceedings are usually only published just in time for

Growl the first.

the following year's Conference, these Conferences are undoubtedly extremely useful. I would like to suggest, however, that they would be far more useful if each Conservator first held a Circle Conference of his Divisional Forest Officers, to discuss questions that are to come up at the Conservator's Conference. This would greatly assist Conservators, especially those who are new to the Province, as so many of our Conservators now are. It would also give the decisions of the Conservator's Conference more weight. The D. F. O. is the backbone of the service, and is far more in touch with things than the Conservator, and he should be consulted more than he is at present. The method of writing round for D. F. O.'s views gives a considerable amount of extra work and gives no chance for discussion. The end of May or early June is a slack time and most D. F. O.'s could easily afford three or four days then for a Conference.

Surely, it is time for another Provincial Conference in Burma. We had one in 1910, nearly seven years ago, and there are many very important questions that have arisen since then. Fire-protection is a provincial question, and not one for a Conservator's Conference. Moreover, there are marked differences of opinion on this question, and a Conference might clear the air. Then we all want to discuss the system of management of teak forests. The 1910 Conference took most of us unawares, and, since then, we have been thinking furiously (some of us, at any rate). I see no reason why some definite policy should not now be formulated.

Other questions are—

1. Forest villages (apparently being fixed up without any D. F. O.'s being consulted).
2. Increased Departmental Extraction. (In these times of scarcity, Government wants all the money it can get.)
3. Game laws. Why in Heaven's name should these be drawn up by Civilians?
4. Specialization of Staff. See Mr. Watson's note in November-December number, 1916.

There are many other subjects, similar to above, which are emphatically not matters for a Conservator's Conference. I would suggest a Provincial Conference at least once in five years.

This deals with subject No. 2 above, *i.e.*, Departmental Extraction. How much longer is Government going to fritter away their vast resources in the forests by selling themselves to lessees? Most of the forests in Burma have been given out, as far as teak is concerned, to big firms at a perfectly absurd rate of royalty, for long periods of 15 years. These firms do not issue a balance-sheet for their dealings in teak, but, if issued, it would prove interesting reading. Making allowance for very high costs of extraction, agency charges and the like, I do not see how it would be possible to make a clear profit of less than the royalty paid to Government. As a matter of fact, it is probably at least twice that amount from many forests. It is only to-day in the paper that I came across the following headed "The Empire's Resources":—

Growl the second.

> "Reuter learns that an Empire Resources Development Committee, under the chairmanship of Sir Starr Jameson, has been formed with a view to promote the development, by the State, of the Empire's resources with a view to assisting payment of the War Debt."

After giving the names of the influential persons included in the Committee, the report goes on to say:—

"The Committee advocates—

"*Firstly*:—Conservation, for the benefit of the Empire, of such natural resources as are, or may come, under the ownership or control of the Imperial Government.

"*Secondly*: Development of selected resources of the Empire under conditions giving the State '*an adequate share of the proceeds.*'"

Why should not Burma teak forests be made to give the State an adequate share of the proceeds.

Another very serious side to the question is that, over the greater part of Upper Burma at any rate, we are now girdling over a large surplus of mature trees which has been accumulating for

many years. All the extra profit of this is going into the hands of lessees. If Government wishes to keep up the revenue from teak timber to its present level, their only way will be to work a far larger proportion of their forests under Departmental Extraction, because the present yield cannot possibly be maintained.

GROWTH OF THE PALMYRA PALM.

Mr. H. J. McLaughlin, D.F.O., Kistna, informs us, as the result of observations carried out for a period of twelve months, that the Palmyra Palm increases in height by six inches and puts out, on an average, 12 leaves during that period.

These figures were obtained from three plants from 6" to 2' 4" in height growing in the open, on sandy soil. They were not watered.

MILITARY CROSS FOR A FOREST OFFICER.

A correspondent informs us that Mr. E. V. Ellis, I.F.S., has received the Military Cross. He was serving with the Royal Naval Division on the Ancre at the end of last year, and headed a bayonet charge when there was some danger of our line being forced back at one point. A bomb landed at his feet but he stumbled forward and got off with a few scratches, and his party took 35 prisoners.

He saw a good deal of service in Gallipoli, and is now Adjutant and Lieutenant in the Home Battalion. We offer him our best congratulations.

EXTRACTS.

TYPHA.

The following extract, from the *Chicago Daily News* of 1st October 1916, has been sent to us by the Secretary, Bengal Chamber of Commerce:—"Capital was subscribed last week by the greatest spinners, merchants and bankers of Germany for the exploitation and manufacture of a new material which, if it meets with expectations, will make Germany independent of the importation of cotton, jute and wool. It is made from a plant called 'typha,' a sort of cat-tail growing in marshes, and can be worked into threads according to the kind of cloth to be made. I have seen samples of the results obtained by the process, so far as it has been perfected. There are many varieties of the plant, having different fibres, which can be worked into coarse jute or the finest cotton substitutes, with all the strength and softness of a cotton fabric. The crop of the 'typha' this year at the lowest estimate is 500,000 tons, while at the highest estimate 6,000,000 tons. The yield in finished product is 10 per cent. When sown with this plant, Germany's extensive marshes will offer an absolutely unlimited supply at a small cost, as no good land is needed. The crop can be gathered from June until the heavy frosts set in, and several crops can be raised in a year as the plant grows as rapidly as alfalfa. Even in the experimental stages of manufacturing, the cost of the cloth shows

a decrease over the normal cost of goods imported. I have been told by a Berlin merchant, whose name is known throughout the world, that Germany as early as next year will make enough of the material to equal all the supplies usually imported largely from America and Egypt. The discovery is considered of extraordinary importance, and it may make Germany an exporter of this product instead of being an importer of cotton, wool and flax. It is recalled here that Germany imported sugar until Napoleon instituted his continental blockade, when it developed beet sugar, and became the greatest sugar exporter in Europe, and independent of imports. The first work with the new capital will be to develop the coarser grades of the material and then, after further experiments, the finer grades. Real results are expected next year."—[*Indian Engineering.*]

[*Typha latifolia* is the greater reed, so common in ponds and ditches in England, where it is popularly, but erroneously, known as the Bull-rush. *Typha elephantina*, Roxb., is common in swampy places in the U. P., where it is locally known as "Paterá." Elephants are fond of it as fodder, in the hot weather, and it is also a good lie for tiger at that season.—HON. ED.]

BALSA WOOD.

In a previous issue of this Journal we made some allusion to the special properties of Balsa wood; from a note in the Proceedings of the American Society of Civil Engineers, August number, we find this timber is attracting some scientific attention at the present time. The writer of the note, Mr. A. P. Landin, says he has met with the wood in Central and South America, Central Africa and also India. If it really does grow in India the attention of the Forest Department might be directed to it for its useful properties. If it does not, the question might be considered of introducing it, since it is a quickly growing timber and is likely to thrive in parts of India similar in climate to those mentioned above. The structure of the wood is practically all pith, the natives of Central and South America use it for rafts both for transporting themselves downstream and for floating produce to

the sea-coast for shipment. Without some treatment the timber gets water-logged and ceases to fulfil its purposes as a float, and as absorption takes place chiefly through its ends they smear the ends with tar or some waxy substance. This is, however, not enough because sufficient water can find its way in even through the bark to render the timber useless for floating purposes in a short time. This defect renders it much less valuable in its natural state than cork for use in life-saving apparatus, it being found necessary to make life-belts two or three times as large as cork life-belts to be really reliable. Experiments have been made to render the wood impermeable by ordinary methods but with little success. When painted it absorbs the paint as fast as it is put on and grows too heavy to be useful; when varnished the internal moisture causes the varnish to crack and blister. Paraffin, asphaltum, gilsonite, etc., have been tried and have succeeded in making the wood fairly impermeable, but owing to the confined moisture in it dry rot has quickly set in. There is, however, a patent process that has apparently proved a success; this is Colonel Marr's water-proofing process which has been tried by the United States Government with Balsa wood life-preservers, life-buoys, etc. Subjecting these to immersion continuously for 49 days together with similar ones made of cork, it was found that the latter had completely lost their buoyancy while the Balsa ones retained theirs to the standard required.

But perhaps the timber is destined to fulfil a more useful purpose as an insulator. Mr. Landin tells us he tried it, to begin with, as an ice-box with surprising results. In the hot summer weather of New York ice did not completely melt out of the box for a whole week. There can be no doubt of its being an excellent non-conductor, and as such it opens up large possibilities of usefulness in a tropical country like India. First there is the lining of refrigerating cars, next the lining of all-steel railway cars. As a ceiling for corrugated iron sheds used to such an enormous extent for railway and general industrial purposes in this country it should prove a boon: nor is there a reason why in the very hot parts of India its use should not be extended to the internal lining

of flat terrace roofs and even brick or stone walls, taking the place of plaster and whitewash. The point about Balsa is that whereas other non-conducting materials are used merely as linings to conductors, *it being itself a non-conductor as well as a constructive* material can be used alone. There is a very wide field in the present day for the extension of trade by means of cooling chambers, the rise of local prices and the development of com*munications must all tend to the carriage of perishable goods* over long distances by sea and land. Were insulation and refrigeration made cheaper there might soon be no limit to their use; and if Balsa wood is going to help to solve the problem it claims careful attention. In America Professor Carpenter has taken up the scientific part of the enquiry; in India we trust the Forest Department will take it up from the point of view of supply. Perhaps the Department could tell us if the timber really does grow in India and if so where and to what extent.—[*Indian Engineering.*]

VOLUME XLIII NUMBER 6

INDIAN FORESTER

JUNE, 1917.

THE FORESTS OF NORTHERN CHAMPARAN.

BY H. H. HAINES, I.F.S.

The province of Bihar and Orissa is not supposed to possess any forest north of the Ganges and, so far as Government forests are concerned, this is, unfortunately, true. Practically the whole of the northern districts is a monotonous cultivated plain, some grass-lands, jhils and marshes alone supplying a touch of Nature—touches which, I suppose, some of our hygienic fanatics would wish to treat with kerosene oil or fill up! The greater part of the northern boundary borders the Nepal Tarai at a considerable distance from the hills but, in the extreme north-west, the common boundary of British territory and Nepal recedes, and is carried along a range of low hills situated in the north of the Ramnagar and Bettiah Estates. These hills, with a strip of sub-montane land, are still covered with forest, while there is also a tract of forest, one to three miles wide, along the Gandak river in Bettiah, and a strip along the Nepal boundary on the east. In the Bettiah forests, I made an eight days' tour and drew up a working scheme for them in 1894, and I have recently been able, through the

interest taken in all forest matters by the present Local Government, to make a similar tour on behalf of the Ramnagar Raj.

Although Beharites are not a little proud of this tract of hill, and especially of the glorious view from the hill-station (one bungalow without out-houses and three cooly huts) of Sumeshwar, very little has hitherto been recorded of the forests. The account of the botany of the tract in the Gazetteer is meagre in the extreme. That of the district as a whole is taken from Sir D. Prain's valuable preface to his 'Bengal Plants'; but Sir D. Prain, in referring to this area, says: "Of North Tirhut we know very little, the only collections of importance from the region being those of Buchanan-Hamilton, few of whose specimens are in India now, and more recently those of Hieronymus, the latter being altogether from Bettiah."

The hills belong to the Siwalik system, and they closely resemble the Siwaliks proper in general character. They nowhere quite attain 3,000 feet, and the general height of the main ridge is under 2,000 feet. In Bettiah they do not exceed 800 feet, and the level of the Gandak here is about 300 feet. To the more fortunate beings, who have access to the Himalayas, an evening stroll to their highest point might scarcely seem sufficient recreation; but to some of us, who live on bare plains or denuded plateaux, the Sumeshwar range has the charm of the woods and mountains. An hour's real peace on, for instance, the deserted site of the old Sumeshwar fort (altitude 2,900 feet) is a great mental restorative.

"His daily teachers were the woods and rills,
The silence that is in the starry sky,
The peace that lies upon the lonely hills."

The sense of being really in the mountains is no doubt accentuated by the apparent proximity of the snows and the character of the surrounding vegetation. On the way one passes a Raspberry (*Rubus ellipticus*, Sm.)* ; a Clematis (*C. nutans*, Royle), rambles over the fort ruins, and a tree Boehmeria (*B. rugulosa*, Wedd.), * alongside.

* Species not recorded in 'Bengal Plants' from any part of the area there dealt with (which excludes the Darjeeling District) are marked with an asterisk.

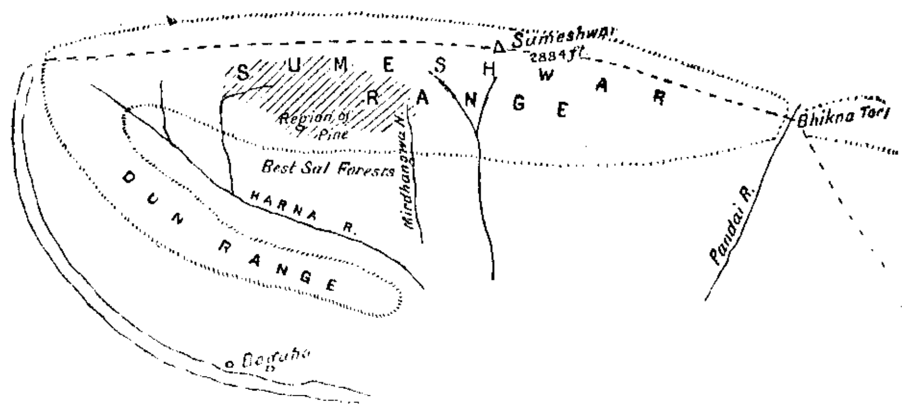
The distance to this point (Sumeshwar), on the Nepal boundary from the edge of the forest at the foot, by a very switch-back path, is eight miles, and this is about the average breadth of the main range, though it would not be more than half in an air line. On the east it thins off to Bhikna Tori, where there is a pass into Nepal through which the Pandai nala flows. To the east of the Pandai, the gradually sloping 'Bhabar' meets the boundary before it reaches the hills. The total length of the main range is about 34 miles, in a line taken by the mythical crow; but on the west a river, the Harna Nadi, flowing south-east, cuts off a subsidiary range of low elevation known as the Dun hills, the broad valley of the Harna itself being the Dun. This Dun range is about 18 miles long and 12 broad. The total forest area, including the jungle lands along the Gandak on the extreme west, is given as 427 square miles, of which some 77 belong to the Bettiah Raj and the remainder to Ramnagar.

The rock of which the hills are composed is almost entirely a fine-grained sandstone interbedded with occasional layers of water-worn stones. It is very easily disintegrated and often falls away in cliffs along the rivers and, as in the Siwaliks, weathers into knife-edge spurs and ridges. These are sometimes so unpleasantly steep on either side that one sometimes elects to sit down and proceed by the aid of the arms. Here also is food for soliloquy, and one wonders whether it is better to return to the ills we had or crawl to others we know not of! One gentleman who accompanied me preferred to do neither but go home by way of the valley.

This broken ground occurs especially in the western part of the main range and, on the tops of the ridges or nestling in heaps of débris at the foot of landslips, at elevation of 1,000 to 1,600 feet, is found the Chir Pine (*Pinus longifolia*, Roxb.), here called 'Dhup.' The old province of Bengal used to know of one forest only of Chir Pine, that of Badamtam, on a dry spur of the Himalayas overlooking the Rangit river. It has not hitherto been generally known that Bihar and Orissa can also boast of a Pine forest!

The distribution of the tree is, however, curiously restricted. It was nowhere seen in the eastern half or extreme west of the range and appears to begin only west of the small Mirdhangwa Nadi (Longitude about 84° 15′). The nearest station at which records of rainfall are available is Bagaha, situated on the banks of the Gandak, about 12 miles south of the outer Dun hills. Here it is 62 inches. It would appear that the Pine is situated on that part of the hills which may constitute an inner, drier zone ‡ in respect of southerly moisture-bearing winds.

The following very rough sketch may better illustrate the *topography* :—



The Pine is exceedingly thin. It has been partly cut out and tapped for resin ; and although a number of seedlings occur, many two years old, the periodical fires usually prevent their development. Associated with the Pine on these dry hills are a few Sal, but, in general, little more than grass, including the Sabai or Bhabar grass (*Ischæmum angustifolium*, Hack.). There are also in some places rather a remarkable number of *Bauhinia purpurea* (Koilara) † of which the Tharus, like the natives of many other districts, eat the

‡ In Mr. Troup's excellent monograph on the Chir Pine many statistics of rainfall are given. In comparing these it has to be recollected that the outer, and unprotected Sumeshwar hills have probably a much larger rainfall than Bagaha.

† Vernacular names in bracket are the Tharu names.

leaves. Here also is the *Grewia helicterifolia*, Wall., * so common in the Siwaliks and here attaining 5 or 6 feet. It ascends to the top of the range together with *Lespedeza macrostyla*, Baker, * and *Inula Cappa*, DC.,* *Eriolæna Wallichii*, DC.,* a large-leaved shrub, or small tree, is also frequently associated with these plants. A small grey-brown squirrel was seen apparently feeding on the unripe fruits of the *Bauhinia*. A very common bird on the dry ridges is a white-cheeked Bulbul with a yellow vent and quite a ridiculous crest, reminding one of Mr. Punch's headgear.‡

The forests are mostly Sal forests, intersected by strips of mixed forest on the newer alluvium and in the damper valleys. On depressions in the Bhabar at the foot of the hills, on the high banks of the older river valleys and in the valleys themselves where these wind among the hills, and space permits between the river-bed and the escarpment, the Sal attains its best growth. There are now no sound Sal trees in the Ramnagar Estate over 4 feet girth. This is due to past and recent fellings. There is little doubt, however, from the height-growth of the tree and the results of protection in Bettiah that it could attain in the more favourable localities a large girth. In the Dun north of the Harna, thère are some particularly promising Sal woods, but these are interrupted by cultivation. Some deserted areas of old cultivation have not, however, filled up at all. This is in consequence of the large herds of cattle that graze in these forests as well as to forest fires and exposure. Fires alone would not have prevented the gradual spread of the Sal, as I tried to demonstrate many years ago in the case of the Duars Sal forests. Indeed the benefits arising from early fires were observed by Sir D. Brandis in the seventies, and the Ahirs or cattle-graziers here usually fire some of the grass lands early. Too great exposure to the sun is also unfavourable to the best Sal reproduction. The evidence of fire-lines shows how favourable some degree of lateral shade may be, and this seems to be the conclusion at

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‡ Probably Molpastes leucogenys.—[HON. ED.]

which Mr. Hole and Mr. Marsden, the Forest Botanist and Silviculturist respectively, have arrived. Probably the Group method of treatment or a Selection system in which considerable holes are made in the cover, is the most favourable system for reproduction. The reproduction of the Sal in general, in these forests, is not as good as it should be and saplings are almost absent, so that the time will come, unless the present system of cutting and hacking is changed, when the better Sal forest will practically cease to exist. It is remarkable that in some of the more shady Sal forests the ground is occupied by a gregarious growth of *Croton oblongifolius*, Roxb. (Mahson), † which would require to be cleared before Sal seedlings could be expected to grow.

On the higher ground in the Bhabar (and of course on ridges in the hills), the height-growth of the Sal is usually poor, and it would not pay to try growing large timber. In such localities, *Dillenia aurea*, Sm., is very characteristic; and, indeed, the distribution of the two Dillenias is quite a good index to the timber-producing capacity of the associated Sal. Unfortunately, the non-botanist finds it somewhat hard to distinguish them in leaf, and both are called Aghai by the Tharus. In flower, nobody could confuse the large handsome flower of *Dillenia aurea* with the small flowers of the larger tree. The undergrowth in the drier Bhabar is often a complete fairy forest of *Phœnix humilis* (Polot, Khajur), sometimes, but rarely, attaining 10 feet in height. This also more or less disappears in the better type forest. The plant is rather a light-demander, and the thinning out of the tree cover by forest fires favours its growth. On yet more open ridges, especially those with fewer stones, this dwarf date gives place to grass, chiefly *Pollinia argentea*, Trin., and *P. articulata*, Trin., *Andropogon intermedius*, Br., and *A. apricus*, *Chrysopogon monticola*, Haines, *Arundinella setosa*, Trin., and Spear grass. The larger and commoner grasses occurring on cleared ground in the lower Sal forests are a narrow-leaved variety of *Saccharum arundinaceum*, Retz., *S. Narenga*, Ham., and *S. spontaneum*, L., and in depressions especially the last, *Anthistiria gigantea*, Cav., and *Polytoca* sp.

† Vernacular names in brackets are the Tharu names.

Other plants of the Sal forests worth mentioning are *Clausena pentaphylla*, DC.* (Rowana), the leaves of which are cooked in mustard oil and used for some disease which I forget, and a very pretty tuberous-rooted *Echinacanthus* (*E. attenuatus*, Nees),* with violet flowers standing erect on axillary laterally spreading panicled spikes.

The newer alluvium shows the usual stages of :—

(*a*) Grass or Khair forest (occasionally Sissu).

(*b*) Grass mixed with Khair and numerous miscellaneous trees especially the Albizzias, Simal, Odina and Karam.

(*c*) Mixed forest.

(*d*) On the older and higher lands, often due to successive deposits of silt, Sal forest.

A large deposit of new silt due to an exceptional flood has, however, sometimes killed an existing Sal wood.

In narrower valleys in the hills stages (*a*) and (*b*) are absent, and mixed forest of a semi-evergreen type also occurs along streams where there is no alluvium. The mixed forest in the larger valleys contains a large variety of trees but, whereas on the Ramnagar side of the boundary, east of the Pandai river, these trees are usually small and of little value, on the Nepal side the forest contains very fine trees. A walk along this boundary shows the valuable results of protection, the Nepal forests being carefully protected. Here are *Cedrela Toona*, Roxb. (Toon), trees 6 feet in girth, *Sterculia colorata*, Roxb. (Chop), *S. villosa*, Roxb. (Chop), and *Terminalias* (*tomentosa* and *belerica*) over 6 feet and very large, *Bombax malabaricum*, DC. (Simal), and Albizzia. Where Sal crosses the boundary the comparison is equally striking. In the hills the contrast disappears, as the hills here are steep and with naturally poor growth, and little cutting takes place on either side. Near the top of the hills *Rhus semialata* occurs as a very small tree. A large number of *Terminalia Chebula* (Hara), of which the myrabolans are now

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strewing the ground, occur in the drier mixed forests east of the Pandai river.

In the older but damper mixed forests, *Terminalia tomentosa* (Asana) attains a magnificent size, and these large Asana ascend the hills in the valleys nearly to their origin. In a saddle below Sumeshwar, at an elevation of about 2,000 feet, there is a beautiful wood of Asana and Karma (*Adina cordifolia*) trees standing over Bamboo grass (*Andropogon assimilis*, Steud.). This is the spot where a Catholic priest on his way to Sumeshwar some years ago was killed by a man-eating tiger, the spot now being marked by a rude wooden cross. It is a suitable place for worship and not far off is a small ruined and deserted temple buried in the forest. The gods, indeed, appear wonderfully indifferent either to worship or worshippers!

Latterly, a large number of large Asan trees in the more accessible forest have been felled for sleepers. They are very subject to heart-shake (the results of fires?) and sleepers are apt to split on drying unless seasoned slowly by covering the ends with mud for about a foot. Mr. Smith, formerly manager of these forests on behalf of Messrs. Dear & Co., showed me some Asana trees known as Ujurki Asana (white Asan). The wood is very pale and is said to be especially hard and tough. Mr. Lethorne, the present manager, has kindly undertaken to send a specimen for the Research Institute. The bark is unusual, being whitish-grey and pealing in long vertical strips. I have noted before ‡ on the variability of this tree, and as the wood also appears to vary much in value it may be a subject worth further study. In the Sikkim Tarai, I recollect that the late Mr. Baker, then manager of the Panighatta Tea Estate, used to say that he preferred Páka Saj (*i.e.*, the ridge Saj, in contradistinction to *Terminalia myriocarpa*, the Pani Saj. In regions of such heavy rainfall as the Sikkim Tarai, *Terminalia tomentosa* prefers the ridges) to Sal for constructional purposes. *Terminalia Arjuna* does not occur in this district. *Terminalia tomentosa*, as is well known,

‡ Forest Flora of Chota Nagpur, p. 363, and an apparent hybrid between *T. tomentosa* and *T. Arjuna* is recorded on page 109 of the C. P. List.

stands a very large amount of water and in the damper Asan and mixed forests the ground is often covered with the Pipal (*Piper longum*, L., Long Pepper). Both the fruit and the roots (Pipramul) are valuable and leases are given of it. It was a little surprising, therefore, to hear the lessor, when a quantity of the plant was pointed out to him, exclaim "Well, I had always wondered why they paid so much for Peepul trees"!

In the mixed forests are also found *Amoora Rohituka*, W. & A.; *Bischofia javanica* (Areng) up to 5 feet girth; Mango; *Putranjiva Roxburghii*, Wall., rare; *Celtis tetrandra*, Roxb., rare; *Pterospermum acerifolium* (Machkan), rare; *Ficus Benjamina*, var. *comosa* (Lakhar), a handsome tree in the Bettiah valleys; *Sideroxylon tomentosum*, Roxb. (Panial); *Cedrela Toona* (Tun); *Miliusa velutina* H.f. (Kariota); *Trewia nudiflora* (Bilur); *Ficus Rumphii*, a large tree of epiphytic origin; *Albizzia Lebbek* and *A. odoratissima* (Gobraha); *Albizzia lucida* (Gobraha) and other commoner trees. *Sterculia fulgens*, Wall.* (Phap), described as a small tree by Masters in the Flora of British India grows to 8 feet girth in the lower mixed forests and ascends to 2,000 feet or more often on dry aspects. There used to be a specimen of this tree opposite the Dehra Forest College but, without comparing with the type, the diagnosis is a little doubtful. On the hills it is a small tree but then the description of the leaves as 10 by 6 inches and pubescent is inapplicable as they are as broad as long, and very persistently velvety-tomentose beneath.

This tree flowers in the hot season and indeed the cold weather, especially from the middle of November (5) to the middle of January, is the very worst season of the year for botanizing. The majority of the plants here noted had neither flowers nor fruit, and there must remain a large number of interesting species unrecorded in consequence.

In semi-evergreen forests and along streams *Bassia butyracea*, Roxb. (Chiuli),* *Meliosma simplicifolia*, *Saraca indica*, *Heteropanax*

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(5) My visit took place at the end of November.

fragrans, Seem., *Brassaiopsis* (sp.?) and numerous shrubs and herbs occur, of which the most interesting are *Ficus lanceolata*, Ham., with large edible figs; *Hyptianthera stricta*, in fruit; *Gymnosporia rufa*, Wall.*(?), in fruit; *Rivea ornata*, Chois, in fruit; *Murraya exotica*, the Chinese Myrtle, on rocks in ravines and *Murraya Koenigii*, Spreng. (Bakler), the leaves of which are used in curries; *Phlogacanthus thyrsiflorus*, Nees* (Chuhar), of which the leaves are used for fever; *Osbeckia nepalensis*, Hook., with large white flowers; *Melastoma malabathricum* (Dantgijiri) of which the Tharus eat the pulpy placentæ and seeds; and *Osbeckia gracilis*, Bedd.,* or, at least, a species corresponding closely to that plant, in flower and fruit.

A very pretty species of *Uraria*, undescribed in the Flora of British India or Bengal Plants, is common in damp localities above 1,500 feet. It has large panicles of pure white, lilac or blue flowers remarkable in the genus for the long (coloured) pedicels.

Also should be mentioned *Rubia angustissima*, Wall.,* a plant with whorls of linear leaves and looking like an Asparagus! Every part of it is intensely scabrid, by which feature it makes efforts, more or less futile, to pose as a climber.

Of real climbers there are very many. *Bauhinia Vahlii* (Maulan) was seen 4 feet in girth at one place. This and *Spatholobus Roxburghii* (Ramborla) are the most destructive climbers in the Sal forests from the plains upwards. The fruits of the *Spatholobus* are plucked in immense quantities by the Langur. The thin red basal portion is eaten and the apical seed portion is thrown away. "A wonderful provision for the distribution of the plant!" The chief objection to this new explanation of the wing being that none of the seed was ripe. The climbing *Butea* was not observed. It is chiefly a central Indian species, but another species of *Butea*, probably *B. minor*, Ham.,* in ripe fruit is abundant under shade at the higher elevations. It is sub-erect and never seen by me climbing although this species is described as scandent by Baker in the Flora of British India. The inflorescence*

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(now dry) is a sub-simple raceme at the top of the stem, or the whole top of the stem with numerous axillary racemes becomes a panicle, and in this case the flowering stem dies to the ground after fruiting. I have seen the plant with the same habit in the forests of British Bhutan. In the valleys, the snow patches of the Bridal Creeper (*Porana paniculata*, Roxb.), now in full flower ([4]) are very conspicuous, and another handsome climber found along streams, and just beginning to flower, is *Thunbergia coccinea*, Wall.,* with pendulous racemes of crimson bracts and orange-scarlet blooms. The *Mezoneurum cucullatum*, a prickly climber with bi-pinnate leaves and handsome with its yellow lipped flowers, is rampant in scrub jungle near streams. Mr. Burkill states that it is ornithophilous. Of other climbers worth notice are the large *Mucuna* with plaited and winged pods (*M. imbricata*, DC.),* a plant, like its congeners, to be noticed at a respectful distance, and a huge *Hippocratea*, *H. arborea*, Roxb. ([5]).* (Damanahar). The stems of this species attain 2½ feet girth. The wood appears to have normal structure. The plant climbs by occasionally making a coil in its stem or branches, and as these grow and become woody round their supports, it does not find it necessary to have many of them. The short branches with only three to four pairs of leaves simulate compound leaves.

There is besides a second scandent cirrhose species of *Bauhinia* (Nagpheni) with acuminate lobes to its leaves. It is neither in flower nor fruit, and I am unable to identify it without herbarium specimens. The large milky-juiced apocynaceous climber, *Chonemorpha macrophylla*, G. Don., occurs associated with the last in ravines. It has leaves attaining a foot long and eight inches broad. *Clematis Gouriana* also occurs near water-courses and *Naravelia zeylanica* in the Bettiah forests. *Cudrania javanensis*, Trecul., is a spiny sarmentose shrub and the long pendent fleshy roots, beloved of

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([4]) November and beginning of December.

([5]) Prain gives *H. indica*, Willd., as occurring in Bihar. *H. arborea* differs in the leaves attaining 7″ and the fruiting carpels 2·25″.

elephants, of the *Tinospora cordifolia* (Guruch) is frequent in riverside jungles. The beautiful climber, *Holmskioldia sanguinea* with its scatlet saucer-shaped calyces occurs in rocky places. It is frequently grown in gardens. The vine, *Vitis divaricata*, Wall.,* is a very common species here, not elsewhere met with in the province. It occurs from the base to the top of the hills being especially abundant at about 2,000 feet. Above 2,000 feet were also observed *Sabia limoniacea*, Wall., (probably) and *Smilax lanceæfolia*, Roxb.,* both near water-courses. A scandent Derris is undetermined, as well as a 3-foliolate Jasmine, closely allied to *J. caudatum*, Wall.,* if not actually that species. The flowers were over, but an old one was recovered from a badly arranged collection of natural-history specimens in a spider's web. This account of the climbers in these forests is by no means exhaustive even for the woody species.

In spite of the great dryness of the soil on some of the ridges, temperature is never very excessive and the humidity probably never very low. Plants of marked xerophytic structure are, therefore, rare. The Pine may count as one. The large fleshy *Euphorbias* are absent, but are represented by *Emphorbia fusiformis*, Ham., an interesting plant with fleshy leaves looking like a seedling of one of the larger species. It has a large woody root-stock buried in the sand. Another plant, *Streptocaulon sylvestre*, Wight., frequent on sandy soil, is a creeping herb with a woody root-stock and distichous rather fleshy oval leaves which lie closely adpressed to the ground. The fruit (unknown when the F. B. I. was written) is poiniard-shaped 2·5—3″ long and grooved on one side, not with two divaricate follicles as in the rest of the genus.

In grass-lands, all three species of *Calotropis* occur, but *C. Acia* also in Sal forest. *Grewia sclerophylla*, Roxb. (Dapher), is very common on grass-lands which were originally under Sal forest. The fruit is eaten. The other dwarf species *G. sapida* also occurs and the dwarf *Ochna* (*O. pumila*), while in March, the period of my previous Bettiah visit, the dwarf *Careya* (*C. herbacea*, Roxb.), was conspicuous with its bright red shoots and large white and pink flowers almost at ground-level.

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THE NATURAL REGENERATION OF CONIFEROUS WOODS.

BY C. G. TREVOR, I.F.S.

In a previous paper,* I have dealt in detail with the silviculture of the Deodar *(Cedrus Deodara)*, tracing its life-history from the germination of the seed to the final crop. I have endeavoured to explain the conditions necessary to obtain successful regeneration, and have pointed out the system of management indicated, in order to ensure these results. I showed that the Indian Selection system, under the conditions met with in Kulu, had been an absolute failure, and I urged the adoption of a more enlightened system of management, under which definite areas would be allotted for regeneration within a definite period of time.

The fundamental principles of forest management consist in the attainment of the normal forest and the establishment of regeneration to the normal extent (Troup: *Some Notes on European Silvicultural Systems*, page 2), and any system which does not aim at these results is not a silvicultural system at all. I do not propose to discuss further the question of the various systems which may be adopted. I dealt with this subject in my former paper, and the general opinion of foresters to-day is that the Selection system of the past has served its time and that, for the future, some definite silvicultural system, prescribing definite areas to be regenerated in a specified period of time, should be adopted.

This question has now passed out of the realm of abstract discussion and has assumed a practical reality. The preliminary working-plan report for the Kulu Division embodies the enlightened principles of management urged by some foresters for several years past, and a reference to the chief features of the proposals may be of interest.

The object of management is the attainment of the normal forest and the establishment of regeneration to the normal extent, and, in order to effect this, the method of treatment adopted is the Regular or Shelterwood Compartment system. "No rigid adherence to the theoretical principles of the Regular or Shelterwood

* *Indian Forester*, November 1915, p. 439.

Compartment system will be insisted on. In some cases, it may be possible to carry out *in toto* the principles of this system ; in many cases, however, owing to the existence of groups or large patches of canopied 3rd and 4th class trees, it will be necessary to regenerate by amalgamating the theory both of the Regular and the Group systems. Strip fellings against the sun may also be tried on south and south-west aspects, where considered of advantage. Generally, wherever practicable, a single seeding felling will be made over the whole area to be regenerated, but wherever good groups of advance growth or canopied patches of 4th class, or even it may be 3rd class, trees are found, these will be retained to form part of the future crop. Within these limitations, the execution of the necessary regeneration fellings will be left to the silvicultural knowledge of the marking officer, who will so manipulate the canopy of the mother trees that regeneration is obtained and, at the same time, an undue growth of weeds prevented. This manipulation of the canopy will necessarily vary according to the species dealt with. It would be absurd to lay down any dogmatic system of management in dealing with species so different in their silvicultural requirement as the Chil (*Pinus longifolia*) and the silver fir *(Abies Webbiana)*, var. *Pindrow*. Every species comprised in the Regular and Fir Working Circles will be dealt with according to its own individual requirements.

The essence of the silviculture of the new plan is to grow each species of tree in the locality most suitable to it. While making every effort to increase the proportion of Deodar in the mixed forests on all localities suitable to this species, no endeavour will be made to grow exclusively Deodar in forests now occupied by other trees. The mixed character of the crop will be maintained and, taking nature as a guide, the whole area placed in periodic block No. 1 will be regenerated with that species most suitable to the different factors of locality found in every compartment. In places not suitable to the growth of coniferous trees, walnut and ash will be substituted for the rubbish now cumbering the ground, and the resultant crop may be one in which all species are represented, each growing in that portion of the forest most

Fig. 1. Natural Regeneration. Secondary Felling completed. Young crop—Mixed Kail and Deodar.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Natural Regeneration of *Pinus excelsa*, after completion of the seeding felling showing group of advance growth retained and freed. Burning of exploitation refuse now to be done. Kalga, Swagani Maidan, 9,000 ft.

suited to its individual requirements; all together growing up to form an even-aged fully stocked wood, putting on the maximum annual increment and, when mature, yielding a revenue per acre far in excess of anything contemplated in the past."

The forests to be worked on this system have been divided into two working circles :—

(i) The Regular Working Circle.

(ii) The Fir Working Circle.

(i) The Regular Circle comprises the Chil *(Pinus longifolia)*, Kail *(P. excelsa)*, Deodar *(Cedrus Deodara)* forests and the portions of these forests containing spruce *(Picea Morinda)* and silver fir *(Abies Webbiana)*, which cannot be conveniently separated from them. Chil is included in this circle as the area of this species is too small to justify separate treatment. The rotation adopted will be that most suitable to the Deodar, which is by far the most valuable species, for the present this is assumed to be 120 years.

The area of the circle will be divided into four periodic blocks and each period will be of 30 years' duration.

COMPARTMENTS.

Each forest will be divided into suitable compartments bounded, so far as this is possible, by natural features of the ground or by roads or paths duly marked on the maps. All compartments, whether formed by natural features or bounded by arbitrary lines, will be clearly demarcated on the ground and shown on the 4" working-plan maps which will be prepared for the purposes of this plan.

Sub-compartments, to facilitate description or working, will be made where necessary. Compartments will be given a separate series of numbers, for each forest bearing a local name. Sub-compartments will be indicated by small letters separately for each compartment.

METHOD OF TREATMENT.

The silvicultural system adopted will be Regeneration Fellings according to the Regular or Shelterwood Compartment system as indicated above. It may be well, however, in this place to elaborate the information already given, and to deal with the individual

silvicultural requirements of the different species comprised in this working circle. On N., N.-E., and N.-W. aspects, at ordinary elevations, experience has shown that the ordinary seeding felling, leaving the mother trees equally espaced at an approximate distance of 50 feet apart, will give the most excellent results for Deodar (*Cedrus Deodara*). The espacement must of course vary according to the size and species of the mother trees and the aspect dealt with, and this can only be rightly attained by the eye of experience. Two exactly opposite considerations have to be compromised: (1) the necessity for retaining sufficient trees to keep down the growth of weeds, and to produce an ample crop of seed, at the same time sheltering the young growth, and (2) the necessity of removing all cover not absolutely necessary, so that the subsequent fellings of the overwood will do as little damage as possible to the young regeneration. On S. or S.-W. aspects, the difficulty of obtaining regeneration is much increased, and on these aspects I would urge the necessity of side shade to the young plants. An examination of Dhamsu Kalaun forest has clearly demonstrated the necessity for side shade in the case of such aspects. The profuse Deodar regeneration existing throughout the spring and summer of 1915 has largely disappeared from situations devoid of side shade, while where this assistance has been provided the seedlings are in good condition. In such situations the utmost skill in opening the canopy will be necessary, and here regeneration by strips and groups may well be tried. It should be remembered that while Deodar seed will germinate under any sort of canopy, the young seedlings must receive sufficient light if they are to flourish, and if this is not provided in due season absolute failure of regeneration will result. Deodar is, in no sense, a shade-bearer; it requires protection from drought, and consequently, on certain aspects, some extent of side shade; but having once passed the critical stage of the first few years, this species demands ample light. Except where standards are left to put on increment, there is no object in retaining an overwood once reproduction is fully established, *i.e.*, when it has attained an average age of between 5 and 10 years.

The Kail or blue pine (*Pinus excelsa*) is a light-demander and its natural regeneration generally presents no great difficulty when once this is realized. A bright seeding felling is necessary, and experience has shown that even where sufficient light had been provided for the existence of Deodar, Kail reproduction was not obtained until the canopy was well opened out. A word of caution is, however, necessary against the clear fellings of large gaps as has at times been perpetrated under selection in groups, the result of which has been a profuse growth of weeds which has necessitated much labour and expense for artificial restocking.

The silviculture of the Chil (*Pinus longifolia*) is already well known. It is a greater light-demander than the Kail (*Pinus excelsa*), and the success of the silvicultural system now adopted has already been proved in practice. It suffices to say that a very bright seeding felling is necessary in Kulu where this species is growing at an average elevation of 5,000 feet, and that old, large-crowned trees should be selected as seed-bearers.

In addition to the above three species, a considerable amount of spruce (*Picea Morinda*) and even silver fir (*Abies Webbiana*) will be contained in this working circle, and their regeneration will proceed in accordance with their silvicultural requirements. These species will either occupy the upper portions of the forests, consisting of pure spruce or of a mixture of the two firs; or they will occur mixed with more valuable species as in certain forests of the upper Parbatti (Nakas and Kalga), which contained a mixed crop of Kail, silver fir and spruce. The mixed Deodar and spruce forests, so common in Chamba, are not found to any great extent in Kulu, but where they occur, the mixture will be retained and the proportion of Deodar in the mixture greatly increased. Exceptional instances are found of Deodar mixed with silver fir and *Quercus semecarpifolia*; and an enumeration of all these various types of growth shows the great differences met with in the forests of this circle, and the skill and experience which will be necessary in dealing successfully with all these various conditions, and in obtaining regeneration under all sorts of circumstances. The silviculture of the spruce and silver fir is discussed in dealing

with the Fir Circle and need not therefore be commented on here. It is necessary, however, to remark that a careful study of these species remains to be made, that at present little is known on the subject of their regeneration, and that here an interesting field of research lies open.

The number of fellings, subsequent to the first regeneration felling, is not prescribed, the Divisional Officer will make a secondary felling whenever he considers this desirable, and the number of such secondary fellings will entirely depend on the state of the natural regeneration existing on the ground. Generally, the first thing to be done is to make the first regeneration or seeding felling over the forests of periodic block No. 1, but such fellings can be suspended if, in any forest, secondary fellings become necessary, or if, from want of seed, the Divisional Officer considers the making of seeding fellings inexpedient.

As regards the frequency of seed years, observations seem to show that Deodar produces a certain amount of seed in alternate years but that profuse seeding only takes place at intervals of 4 or 5 years. At Monali some seed is produced every year. Kail seeds to a certain extent every year, Chil only at intervals and spruce and silver fir possibly only in occasional years, but very little is at present known about these species. At present the information regarding seed years is unsatisfactory ; no observations have been made regarding Kail, Chil and the two firs and those regarding Deodar are not very reliable. The year 1912 produced abundant Deodar seed, since when there have only been partial seed years, and 1915 was a bumper year for spruce and silver fir but very bad for Deodar. The considerations which govern the recurrence of seed years are a mystery and long years of research will be required to throw light on the subject.

FELLING SERIES.

In view of the fact that only certain portions of each of the protected forests can be closed to grazing at one time, and that trees have to be provided for right-holders all over the country, it will be essential to have a multitude of felling-series scattered all

over the Division. Each forest will not necessarily be a separate felling-series : these will be arranged with due regard to the condition of the crop on the ground and with a view to provide for the necessary closures. A quarter of the area of this working circle will be allotted to periodic block No. 1, and the allotment to periods will be regulated by the state of the crop now existing. In certain cases in the Upper Beas Valley, the pressure of the population on the forests may render it advisable to divide the area allotted to periodic block No. 1 into two sub-compartments, to be regenerated consecutively in two sub-periods. This procedure will only be adopted where absolutely unavoidable and its recognition necessitates a longer period than might otherwise be necessary. Compartments will only be finally allotted to periodic block No. 1. Provisional allotment will be made for other periodic blocks. It will be recognized that in the case of the latter periods this allotment is entirely provisional, and that the blocks now laid down are by no means invariable, and can be altered at any subsequent revision of the plan.

Calculation of the Yield.

For periodic block No. 1, this will be based on an accurate enumeration of all stems of 12″ diameter and over. The volume of every class will be calculated from the figures already available compiled into yield tables, and from these the total volume of timber standing in the forests of periodic block No. 1 will be obtained. To this volume will be added the increment of this standing crop for half the remainder of the period. This, added to the original volume and divided by the remaining number of years of the period, will give the volume to be removed annually to the end of the period. Or, no calculation of the increment will be made, but the plan revised after 15 years and the yield again fixed. No sequence of felling will be laid down ; it will be sufficient to prescribe that a certain volume will be removed annually from periodic block No. 1 of this working circle. A variation of 25 per cent. plus or minus in the yearly total of cubic feet will be permitted, the plus or minus entries being brought

forward every year in the control forms. The volume of every species will be separately shown for every compartment placed in periodic block No. 1, and while no prescription will exist concerning the volume of different species to be removed in any one year, it will be the business of the divisional staff to so regulate their fellings that an approximately equal amount of the different timbers is exported annually.

In order to ensure continuity of management, administrative measures will be taken to consider every year the fellings to be made during the next three years; and these proposals will be every year revised. So that, in the case of a sudden transfer, information will be available for the succeeding officer, until such time as he has been able to acquaint himself in detail with the varying condition of the forests and mature his own opinions on the subject of the future fellings.

SUPPLEMENTARY REGULATIONS.

In periodic block No. 1, after the completion of the first fellings, all rubbish, bushes, inferior trees, raw humus, exploitation refuse and suppressed advance growth will be collected and burnt, and the soil placed in a suitable condition to receive the seed. The young crop obtained will be weeded and tended and, when this reaches a larger size, cleanings will be carried out as they may be required. In compartments allotted to other periods, systematic thinnings will be carried out on a ten-year cycle, the Divisional Forest Officer being authorized to repeat cleanings and thinnings in young pole crops more often if this is found necessary.

(ii) FIR WORKING CIRCLE: COMPARTMENTS.

Forests will be divided into suitable compartments, chiefly with a view to the creation of suitable felling-series and the possibility of closing to grazing. Generally, these compartments will be very much larger in extent than the compartments of the Regular Circle, and no particular effort will be made to divide these forests in the minute way contemplated in the Regular Circle.

METHOD OF TREATMENT.

The forests of this circle will be regenerated in accordance with the theory of Regular or Shelterwood Compartment system already dealt with. Owing to the maturity of the forests to be exploited, the fellings can generally be carried out entirely on the principles of this method; but a strict adherence to it is not prescribed. Our knowledge of the silvicultural requirements of the Indian spruce and silver fir is, at present, very limited; and the possibility of exploiting these species, which now, for the first time, presents itself, will be utilized to try various methods of regeneration and various amounts of illumination of the canopy, with a view to the discovery of the exact silvicultural requirements and peculiarities of these species, and the most suitable way of inducing their regeneration. The writer believes that it will be found that admittance of considerable light will be necessary to obtain the natural reproduction of the spruce, and observations have shown that while seedlings of silver fir will persist in dense shade, yet their development under these conditions is much retarded, even to such an extent that saplings 20 feet in height have been found to exceed 40 years in age. It is believed that, at the high elevation at which it grows, even the silver fir will require a certain amount of illumination in order to induce its natural reproduction, and that once reproduction has been obtained full light will be necessary for its proper growth and development. Wherever patches of advance growth may be found, there is no reason why the principles of the Group system should not be made use of, and the advance growth thus found utilized as the nucleus of a future group. Generally, as in the case of the Regular Circle, the marking officer will so manipulate the canopy of the mother trees as to obtain natural reproduction, while at the same time preventing the growth of noxious weeds. No precise method of executing the regeneration fellings is laid down; it will be enough to prescribe that regeneration fellings will be carried out, leaving it to the knowledge and experience of the local staff to decide in each and every case the amount of illumination desirable, and the most suitable manner in which the fellings should be made.

Felling Series.

Owing to the fact that all the forests of this circle, with the exception of a few reserves, are burdened with grazing rights, and that the grazing of sheep and goats is incompatible with the regeneration of coniferous forests, it will be necessary to divide these forests into numerous felling-series, so that in many cases one forest will form one or more separate felling-series. To work these forests in the most efficient manner for a future anticipated enormous yield, it would have been preferable to have taken one whole nullah and allotted it to one period, so that machinery both for sawing and extraction could have been utilized to its greatest efficiency; but, in the present circumstances of the record of rights, this is impossible.

Calculation of the Yield.

The rotation having been fixed at 150 years, the forests will be divided into five periodic blocks, each period having a length of 30 years. The volume existing in periodic block No. 1 will be calculated by a careful enumeration of all trees 12 inches in diameter and over, in exactly the same way as that contemplated for the Regular Circle. To this volume, existing at the commencement of the period, will be added the calculated increment for half the period; or the yield will be re-calculated after the lapse of half the period, no increment being added; and this total volume, divided by the number of years of the period, will give the annual yield. This annual yield may be removed as desired by the Divisional Officer; and, when the necessity arises, administrative measures may be taken, to settle the fellings of the next few years in the way described for the Regular Circle.

Supplementary Regulations.

On the completion of fellings all refuse, bushes, raw humus and such like rubbish will be collected and burnt in exactly the same way as prescribed for the Regular Working Circle.

Sowing and planting will be done in both working circles in order to complete natural reproduction.

Fig. 3. Regeneration. Deodar marked for felling to free the group.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 4. Exploitation and Regeneration.
Lower branches of mother tree to be pruned.

Having dealt with the proposals of the new plan, a few remarks on the practical side of the question may not be out of place. Firstly, I wish to show that the carrying out of this improved silviculture is not so difficult as has been supposed. For many years, it was assumed in India that advanced silviculture was impossible with the establishment available, and that operations such as seeding fellings, thinnings, etc., could not be efficiently carried out by subordinates. I would dissent from this view and maintain that properly trained men can be got to do this work. A seeding felling is something quite new to the Punjab, and it would be absurd to expect a Forest Ranger to be able to make one straight off; but, after training by the Divisional Forest Officer and some experience, these men can be got to do the work perfectly well under normal conditions. Some forests present great difficulty, especially where it is necessary to amalgamate groups of old advance growth with the new regeneration, and here the Divisional Forest Officer himself should do the work. In Kulu the regeneration markings are almost entirely done by the Divisional Officer, but several Rangers have now been trained to this work and are fit to be entrusted with it under supervision. The treatment of each forest must of course be carefully considered and regulated by the Divisional Forest Officer, on whom the responsibility for successful regeneration lies, but subsequent to this certain markings can be carried out quite well by the subordinate staff.

All species are already being regenerated under this silvicultural system. It is too early to speak of results, except in the case of the experimental areas started in 1913, but these latter have given excellent results in most cases. In Phetaban complete natural regeneration of deodar has been obtained without any expenditure except for fencing. This is of course exceptional, but with a moderate expenditure equally good results on a large scale may be expected. It has been found in practice that marking, under the new system, presents no difficulty where the crop is mature. The most intricate forest marked was Nakas containing a mixture of silver fir, Kail, and spruce where there was

considerable advance growth of silver fir, and where this species was rapidly exterminating the Kail, which is of much greater value. If the marking had been confined to the removal of mature trees over advance growth, the crop would at once have been converted into an almost pure silver fir wood which was certainly not desired. The marking, therefore, consisted in retaining a large proportion of Kail mother trees, in reserving silver fir advance growth in groups where required, and in removing the surplus advance growth of fir. The espacement of mother trees and the brightness of the felling were accommodated to the requirements of the Kail. At the completion of the exploitation, the whole ground was covered with a thick layer of refuse: this is now being burnt, and the surplus advance growth of silver fir cut out, and Kail seed sown broadcast as the work is finished. It is hoped, in this way, to maintain and even increase the proportion of Kail, while maintaining the mixture with silver fir; and to obtain a new crop with Kail occupying the ground most suitable to it, either pure or mixed, sometimes in groups, sometimes by single trees, with silver fir in the damp depressions and with a proportion of spruce scattered through the whole crop. The cost of the above work complete in all respects is Rs. 5 per acre. If it had not been for the heavy cutting of advance growth, the cost would have been much less; and near villages, where much of the felling refuse is taken away for firewood, the cost decreases considerably, sometimes to such an extent that little or no work is required. Work is also going on at Nagni in a somewhat similar manner. Here we have a Kail forest, with spruce fir on the cold aspects, and alot of bird cherry and rubbish growing on damp fertile soil, and a little Deodar in certain places. A selection in group felling was made in 1910 which, instead of facilitating reproduction, has been a source of great trouble. Very large groups were clear felled, sufficient seed-bearers were not left, in some cases the reserved mother trees have died, and an obnoxious undergrowth of weeds has sprung up in these gaps in which natural reproduction is quite impossible. Here persistent clearing of rubbish, sowing, planting and heavy weeding is the only solution of the difficulty. In more favourable places, a

nice crop of Deodar, resulting from the seed of 1912, is coming up naturally and has been tended. The felling débris was burnt in 1912 and Deodar and Kail sown in the burnt patches generally with great success, but these patches are often islands in the midst of the weeds already described, and will have to be joined up artificially. The excellent advance growth of Kail is retained, also the crop of mixed Kail and spruce saplings found in irregular masses in the area. That portion of the compartment under regeneration, which is covered with bird cherry and other worthless growth, is being stocked with walnut, both by direct sowing and by planting, and some ash will also be introduced here as soon as nursery plants are available. It has been found in practice that the great danger to guard against is the excessive opening of the canopy which, in many places, will only result in an abominable growth of weeds. In such places, a careful examination of the ground during July 1916 disclosed no natural reproduction of Kail; whereas, under a light shelterwood of mother trees, this was profuse. Personally, I have become convinced that the chief causes of the absence of satisfactory fir reproduction are: (1) excessive humus, (2) grazing, (3) insufficient light; and, by eliminating causes (2) and (3) where they do not exist, I am driven to conclude that cause (1) is very largely responsible for the failure of fir reproduction which is such a striking feature throughout this zone. Experiments on this point are in hand, and a few more years' experience should show whether this belief is well founded or not. There remains little more of general interest to add; we have learnt that Kail, spruce and silver fir all germinate only after heavy rain from June to August; we have now acquired a general idea of the density of the overwood necessary for Deodar and Kail, but as yet we have learnt very little about the spruce or the silver fir. This matter is under investigation, and experimental fellings on the Group and Regular systems have been made at Pulga; and, in the course of time, we shall obtain a fairly exact knowledge of the silvicultural requirements of these two species. I have not dealt with the Chil *(Pinus longifolia)*, as this species has already been fully dealt with in Mr. Troup's admirable monograph

on this tree to which there is nothing to add. The attached photographs (Plates 12 to 14) showing various silvicultural operations will explain the standard of work required under the new working-plan. Plate 12, Fig. 1, illustrates the progress of natural regeneration of Deodar and Kail, and illustrates the appearance of the crop subsequent to the conclusion of the first secondary felling. Plate 12, Fig. 2, shows the new method of treatment in blue pine forest at 9,000 feet. The first regeneration felling has just been finished and the group of Kail advance growth freed of overhead cover. The work of clearing the felling refuse will now be taken in hand, and, to expedite regeneration, the burnt patches will be sown up. The other plates (Plates 13 and 14) illustrate various stages of natural reproduction and various silvicultural operations and explain themselves. In conclusion, I would urge on all foresters the great importance of the exact study of the silvicultural peculiarities of these coniferous trees, so that a knowledge of the most suitable methods of obtaining natural reproduction under any particular conditions may be obtained. I would urge the immediate study of this subject in all hill divisions. Sample areas of 10 to 20 acres are quite sufficient for this purpose, and provided these are carefully observed and notes on them written up from time to time in research journals, the results obtained will be quite reliable. The ideal to be aimed at is the obtaining of natural regeneration in the cheapest and quickest way possible, and I suggest that such experimental areas for Deodar, Kail, spruce and silver fir be started without delay and arranged so as to compare the results of various densities of shelterwood and various methods of regeneration; so that knowledge may be increased and the day hastened when all our forests shall be managed under true silvicultural systems, leading ultimately to a revenue far in excess of anything contemplated in the past.

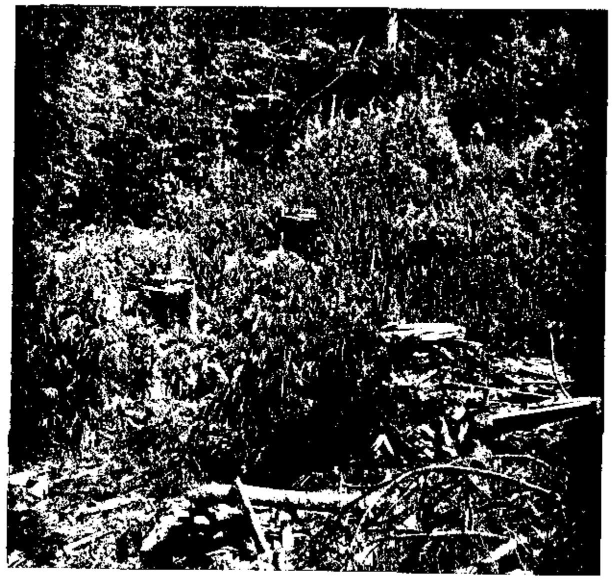


Fig. 5. Regeneration in groups. The final felling ; blank area to be cleared and sown up.

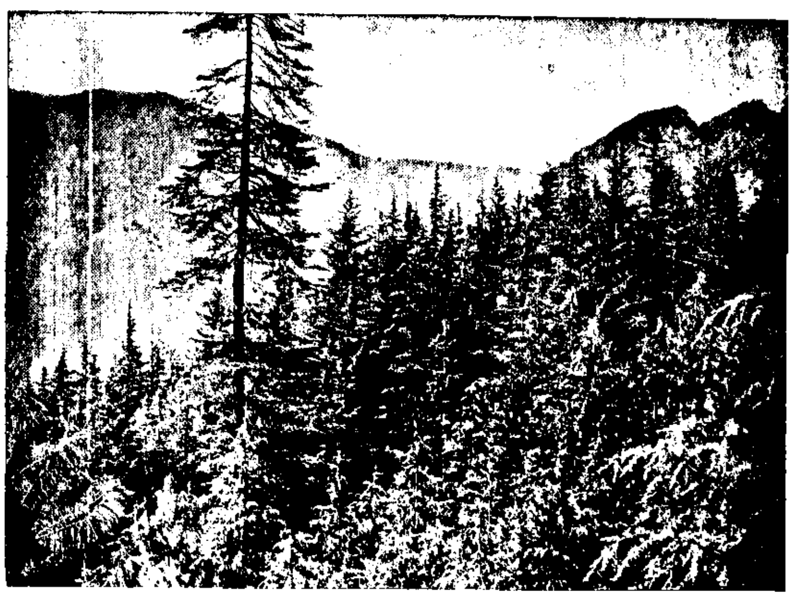


Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 6. The last of the overwood.

THE INDIAN SPECIES OF *ISEILEMA*.

BY R.S. HOLE, F.C.H., F.L.S., F.E.S., FOREST BOTANIST, DEHRA DUN.

When Mr. D. O. Witt, Deputy Conservator of Forests, was preparing his List of Fodder Grasses found in the Berar Forest Circle of the Central Provinces (pub. Allahabad, 1911), he found it impossible to deal satisfactorily with the local species of **Iseilema**, a genus which includes what is probably the most valuable forest fodder grass in the Indian peninsula. Mr. Witt recognized in the field two obviously distinct plants which, moreover, differed greatly in their economic value. On sending specimens of these to a herbarium, however, he was given the same name, *viz.*, **I. laxum**, for both plants. Still adhering to his opinion that the plants were really distinct species, Mr. Witt provisionally dealt with them as follows :—

No. 57, **Iseilema laxum**, *Hack.*

No. 59, **Iseilema**, sp.

and the matter was referred to the Forest Botanist for study.

During the last few years, therefore, the Forest Botanist has made a detailed study of the Indian species as regards :—

(1) The original types in London and Kew.

(2) The herbarium material available in London, Kew, Calcutta and Dehra Dun.

(3) The living plants grown from seed at Dehra Dun.

This study has shown that Mr. Witt's plants are :—

No. 57, **Iseilema anthephoroides**, *Hack.*

No. 59, **I. laxum**, *Hack.*

and also that the confusion between these two species has hitherto been almost universal. In every herbarium which has been visited specimens of **I. anthephoroides** misnamed **I. laxum** have been found. This confusion has been caused by the inadequate and, to some extent, erroneous descriptions of the species which have been hitherto available. The spikelets which constitute the inflorescence in this genus are arranged in small clusters springing from a boat-shaped leaf called the *spathe*. At the base of each cluster are normally four stalked ♂ spikelets arranged in a ring which are called the involucral spikelets. In the centre of these spikelets is the

main axis of the inflorescence, at the apex of which are a sessile fertile ⚥ spikelet and two stalked ♂ spikelets, the lower nodes of the axis, if any, carrying each one sessile ⚥ and one stalked ♂ spikelet.

In the year 1889, Hackel first described the species **Iseilema anthephoroides** in Vol. VI of De Candolle's *Monographs of the Phanerogams* and by his specific name he emphasized the fact that he regarded the remarkable short, stout, curved pedicels of the involucral spikelets as the primary characteristic of the plant. No definite measurements, however, were given to indicate precisely the length and width which distinguish the pedicels of this species from those of **I. laxum.** Hackel also regarded the absence of tubercles on the keel of the spathe and floral leaf as a character of primary importance ; whereas, in this species, the tubercles may be present or absent in one and the same plant. Hackel also overlooked the very important character afforded by the hairs on the back of glume I of the ⚥ spikelet at the base.

As a result of the present work, the key shown below has now been drawn up and it is believed that this will render the identification of the Indian species of this genus easy in the future.

ISEILEMA.

Glume I ⚥ spikelet dorsally adpressed hairy at base and ciliate on margins in basal 1/4.

Length of pedicels of involucral spikelets not exceeding their width at apex ... 1. **I. anthephoroides,** *Hack.*

Glume I ⚥ spikelet glabrous dorsally at base and on margins in basal 1/4.

Length of pedicels of involucral spikelets often not exceeding their width at apex, ⚥ spikelet 0·24—0·32 *in.*, spathe often tubercled on keel ... ... 2. **I. argutum,** *Anderss.*

Length of pedicels of involucral spikelets exceed their width at apex, ⚥ spikelet 0·09—0·24 *in.*

Spathe and upper floral leaf not tubercled on keel ... ... 3. **I. laxum,** *Hack.*

Spathe and upper floral leaf tubercled on keel 4. **I. Wightii,** *Anderss.*

In general appearance **I. anthephoroides** is a stout plant of low growth with short leaves, while **I. Wightii** is a tall slender plant with long leaves, **I. laxum** being more or less intermediate in this respect between these two species.

I. laxum is a perennial and is generally acknowledged to be the best forest fodder grass in Central and South India, while **I. anthephoroides** is an annual, a much smaller yielder and obviously an inferior fodder plant.

It may now be said that work of the kind described above is of no economic importance and should form no part of the duties of a so-called Economic Botanist. To some extent, this opinion appears to be due to ignorance of the methods, difficulties and scope of systematic work. For a considerable period systematic botany held the field in India. The idea then gained ground that a great deal of systematic botany dealt with species of no value and this eventually led to a strong swing of the pendulum in the direction of so-called economic botany. This resulted in a provision for the economic study of agricultural plants at the Pusa Research Institute and of forest plants at the Dehra Research Institute. The improvement of agricultural crops does not fall within the scope of ordinary systematic botany which deals with wild species. As regards forest plants, however, it is perfectly clear that sound progress in economics is impossible without an extended study of systematics. The non-botanist is apt to think that, with the publication of the *Flora of British India* and the formation of good herbaria at Calcutta, Dehra Dun and elsewhere, systematic work has been completed and has no further scope in India. This, however, is far from being the case. Systematic work is at first necessarily tentative and when, in India, we undertake the detailed study of species in connection with the exploitation of the commercial products yielded by them, which

necessitates the identification of large numbers of individuals occurring over extensive areas and the separation of all individuals belonging to species of commercial value from those which belong to valueless but nearly related species, we are forced to recognize the fact that the descriptions in the Floras drawn up from a few often imperfect specimens are more or less fragmentary and not infrequently misleading. Unless such descriptions are revised, incorrect identifications must occur and these will cause not only confusion but financial loss which may be considerable by obscuring the value and retarding the exploitation of valuable species. In the case of the **Iseilemas** it has been shown how confusion with **I. anthephoroides** has tended to obscure the outstanding value of the fodder grass **I. laxum** and a similar state of things is known to exist in the case of commercial timber trees and forest grasses utilized in the manufacture of paper-pulp. A thorough study of indigenous medicinal plants would almost certainly bring many other cases to light and there can be no doubt that there is great scope in India for an extended study of the systematic botany of forest species which is essential for economic development.

As regards the scientific importance of a detailed study of species, attention is directed to its bearing on that question of perennial interest to scientists, *viz.*, the origin of species. The detailed study of species not only accurately defines the specific groups, which is an essential preliminary to a study of their origin, but may also indicate the lines on which our experiments should be organized to obtain the desired proof regarding any particular theory of origin :—

Species are commonly held to have orginated in two principal ways :—

(1) By the progressive accumulation, under the guidance of selection, of small variations or of mutations, the actual cause of which is unknown, but which possibly is to be found in the stimulus supplied by the environment.

(2) By the intercrossing of existing forms.

Method (1) does not lend itself readily to experimental treatment, whereas method (2) can be tested in this way.

If an abstract is made of the important characters of the species of **Iseilema** it will be seen that **I. Wightii** and **I. anthephoroides** constitute two strongly divergent types of possibly different genetic origin.

In the allied genera **Pseudanthistiria, Anthistiria** and **Iseilema** differences in the development of the involucral spikelets usually constitute characters of generic importance. Now, in the raceme of **Iseilema Wightii** there is a tendency towards continued apical development coupled with occasional abortion of the involucral spikelets, whereas in **I. anthephoroides** we have precisely the reverse, *viz.*, a short raceme with very strong development of the involucral spikelets and frequent abortion of the apical spikelets.

Possibly connected with this characteristic is the tendency towards length combined with slenderness which we find manifesting itself in the culms, leaves and inflorescence of **I. Wightii**, whereas in **I. anthephoroides** these parts are characterized by their shortness and stoutness. On the other hand, the remaining species **I. argutum** and **I. laxum** are more or less intermediate between the two extremes and exhibit an intermingling of the characteristics of these extremes such as might possibly have been produced by the intercrossing of individuals belonging respectively to the species **I. Wightii** and **I. anthephoroides**; the merging of some characters giving an intermediate result and the dominance of others producing a resemblance sometimes to one and sometimes to the other species.

Thus as regards habit, length of culms and length of pedicel **I. laxum** resembles **I. Wightii**, whereas as regards length of leaf, hairiness of panicle nodes, length of peduncle and ⚥ spikelet **I. laxum** is intermediate between **I. Wightii** and **I. anthephoroides**. On the other hand, **I. argutum** is intermediate as regards length of leaf, hairiness of panicle nodes and length of pedicels, whereas it resembles **I. anthephoroides** in tubercles on floral leaves and spathes and length of peduncle. If **Iseilema argutum** and **I. laxum** owe their origin to the intercrossing of individuals belonging to the primary species **I. Wightii** and **I. anthephoroides**, we should

expect to find the secondary species in or immediately adjoining those regions where the supposed parents are known to exist. **I. argutum** is confined to Burma and in its area one of the suggested parents (**I. Wightii**) is known to occur, but the other **I. anthephoroides** has not yet been reported. Considering how little we know about the Burmese grasses, however, it is quite possible that **I. anthephoroides** does exist in Burma. **I. laxum,** on the other hand, is practically confined to the area in which both the suggested parents are known to exist. In the case of this genus, therefore, it is possible that experimental crossings of **I. Wightii** and **I. anthephoroides** may indicate the origin of the two species **I. argutum** and **I. laxum**. The actual demonstration that certain species, such as these examples, can be produced by intercrossing, however, would naturally not prove that this was the case with all or even the majority of species, and it is probable that existing species have originated in different ways.

In conclusion the chief points emphasized in this paper may be summarized as follows :—

(1) The necessity for an extended study of systematic botany in India.

(2) The economic importance of a detailed study of species in preventing the adulteration of valuable products with inferior material.

(3) The scientific bearing of a detailed study of species on the question of the origin of species as regards the accurate definition of the specific groups, and an indication of the lines on which experiments may be organized for the purpose of demonstrating their mode of origin.

EXTRACTS.

TRAINING OF INDIANS FOR THE IMPERIAL FOREST SERVICE AT DEHRA DUN.

The principal suggestion regarding the Forest Department does not invite approval. The Commission want to recruit Indians for the Imperial Forest Service in India, and to train them at Dehra Dun. We agree with Sir Valentine Chirol and Sir Murray Hammick that it will be a very long time before Dehra Dun can furnish the equivalent of a European training in scientific forestry. —[*The Times.*]

PRESERVATION OF NATURAL COLOUR IN PLANTS.

So long ago as 1908, Prof. J. W. H. Trail described in the *Kew Bulletin* a method which he had worked out for fixing the green colour in plants. By placing the plant for a shorter or longer period in a boiling solution of copper acetate dissolved in acetic acid, a combination of the copper salt with the chlorophyll was formed which rendered the colour permanent when the specimen was exposed to the light after drying or placed in a preservative solution such as alcohol.

The method deserves to be more widely known than it seems to be among those interested in preparing plant specimens for exhibition in museums or for lecture purposes. It is essentially a method, the results from which gain by experience; different plants lend themselves to the treatment with different degrees of success and require very different periods of treatment; the time for which it is necessary to keep the plant in the boiling solution varies from one minute to forty minutes, according to the action of the copper salt upon the plant. If the action is proceeding satisfactorily, a period of one to five minutes should suffice; the end of the operation is easily judged by the colour or by treating two different specimens for different periods; a specimen that by such comparison appears to require longer treatment can always be reimmersed to get the desired effect. Many plants, notably the leaves of evergreen shrubs, are more difficult and generally less satisfactory in the ultimate colour, probably owing to the presence of mucilaginous or decomposition products or tannins. These require long treatment, varying from twenty to forty minutes; after the first immersion they turn yellowish, and then after a time the yellow gradually gives place to green, generally an olive-green. Other plants, notably Aucuba, fail entirely, as they pass from the yellow to a muddy-brown or black colour.

After treatment the plants should be washed (like photograhic prints) in running water for about two hours. They are then dried under as light pressure as is compatible with keeping the plants from twisting, or after shaking off as much water as possible, may be dried in hot sand. In many cases the plants are rendered so flaccid by boiling that sand-drying is difficult or impossible. Plants that have required long boiling not infrequently revert to a bad colour when sand-dried.

Young parts of plants green better than old; better results may be expected from "spring" leaves than from "autumn" leaves.

A stock solution is made by saturating commercial strong acetic acid with powdered copper acetate. For treatment, dilute the stock solution with water in the proportion of three or four

parts of water to one of stock solution. The solution is heated in a non-metallic vessel, glass beakers being probably the most suitable, and wooden, not metal, forceps should be used for manipulating the specimens.

This method has been used at the Natural History Museum for some time past in the preparation of plants for exhibition purposes, and good results have been obtained with cryptogams as well as flowering plants; ferns especially give satisfactory results, and, as Prof. Trail has noted, fresh green Algæ can be successfully treated.—[*Scientific American.*]

THE SANDAL OIL INDUSTRY OF MYSORE.

Encouragement to Graduates in Science.

Mr. Alfred Chatterton, Director of Commerce and Industries in Mysore, now on the Indian Industries Commission, reports on the subject of the sandal oil industry in that State. At present they are manufacturing oil at the rate of 4,000 pounds per month, worth about Rs. 90,000, and it is hoped that shortly an experimental factory will be able to turn out about 6,000 pounds of oil a month. In 1915 oil had been sold at Rs. 12-8-0 per pound, but since then the price has been raised to Rs. 22 per pound in Bangalore and to Rs. 26-4-0 delivery in London. Government have recently sanctioned the appointment of six more probationers, who are to be Mysoreans and graduates in science of the Madras University. They are to be put through a course of instruction in applied chemistry at the Indian Institute of Science with a view to employment in chemical industries on which we have already embarked, such as sandalwood oil distillation and soap manufacture and those in which we contemplate embarking, such as dry wood distillation, the manufacture of dye-stuffs, and the preparation of marketable chemicals from by-products of these industries. So far the treatment accorded to scientifically educated graduates in India has not encouraged the best talent in the country to take to industrial pursuits for a livelihood, Mr. Chatterton remarks, but it is hoped that in future their prospects will be more attractive

and that better facilities will be provided for their training in manufacturing work on a large scale. The methods pursued in the sandalwood oil factory are methods novel so far as India is concerned. Previous to the war this industry was mainly in the hands of Germans and it has been a source of gratification to all concerned that it has been wrested from them and established in Mysore, so that in future instead of exporting bulky raw material we shall be able to send out an extremely valuable finished product.—[*The Indian Textile Journal.*]

VOLUME XLIII NUMBER 7

INDIAN FORESTER

JULY, 1917.

A NEW SYSTEM OF FOREST EXPLOITATION.

BY R. PARNELL, I.F.S.

Of recent years, there has been fairly general criticism of the system of selling trees standing, to purchasers, on a royalty basis, chiefly on the ground that Government does not get a fair share of the profits of timber trading, with the result that unduly large profits go into the pockets of a few persons with no advantage to the country as a whole. The generality of critics have offered a reversion to the system of departmental working, coupled with the establishment of a special Commercial Branch of the Forest Department, as a remedy for this unsatisfactory state of affairs: it being recognized that, with the great strides that have been made in scientific silvicultural management, it would be impossible to expect the existing trained staff of the Forest Department to undertake departmental exploitation, in addition to its scientific work.

2. In this article, it is proposed to outline a system which would (1) enable Government to get a fair share of profits, and (2) obviate the necessity of establishing a new set of officers,

drawing their salaries, etc., direct from Government, and (3) encourage private enterprise in the timber trade at the same time. The system was suggested, in brief outline, to the writer by a member of one of the large firms of forest lessees in the north of India.

3. The following is an outline of the suggested system :—

(1) The marking of trees for exploitation under sanctioned working-plans, etc., would, as always, be done by the Forest Department.

(2) Recognized firms of timber merchants, with a thorough knowledge of forest exploitation work, would be engaged in the felling, conversion and removal, to sale depôts, of the produce from forests under exploitation. Contracts for this purpose should be for a term of years, five years probably being the shortest term practicable for efficient working of the system.

(3) The work of felling, conversion and carriage would be under the supervising control of the Forest Department, and agreements would contain the usual penalties for illicit and careless fellings, damage to the forest and property of third persons, etc., while security estimated on the basis of 10 per cent. of the estimated profits of the firm would be deposited by the firm. The cost of *special* establishment employed on supervision and a share (equal to the actual time spent on the work by the Divisional Forest Officer and his subordinate staff) of B I *b*, *c*, B I I *b*, *c* charges would be charged against the expenditure on the work.

(4) The firm would undertake to employ managers, assistants, supervisors, etc., approved by the Forest Department, in exactly the same way as is done under the existing system of sales of standing trees.

(5) The capital required to carry out the work would be supplied by the firm, who would be responsible for all payments, subject to rates for felling, logging, sawing, land and water carriage, etc., being approved

of by the Forest Department, and further subject to the condition that no timber should be removed from the forest before it had been enumerated and passed by the Forest Department.

(6) On arrival of the timber at the Forest Department sale depôts, it would be disposed of by the Forest Department, who would, however, have a claim to the expert advice of the firm as to markets, prices, etc.

(7) Once a year, the firm and the Forest Department would prepare a statement of all their expenses on the work during the year, and this statement would be subject to audit by a Chartered Accountant, appointed mutually by the Forest Department and the firm, who would have access to all accounts. In the same way, the receipts of the year would be brought to account by the Forest Department and subjected to audit.

(8) Government (through the Forest Department) would undertake to pay to the firm a fixed rate per cent. per annum for all money expended by the firm during each year, and at the same time arrangements would be made to repay, out of revenue received by sales of timber, as much as possible of the money laid out during the year by the firm. This percentage would presumably be the rate of interest at which Government can borrow money from time to time. These interest charges would be included in the Forest Department's share of the expenses of the undertaking.

(9) At the end of the year, the profits, if any, derived from the undertaking during the year would be worked out, and the firm would be paid a percentage of the profits agreed upon before the contract commenced. This share of the profits would be payable in return for the firm's trouble in management and expert advice in commercial matters, and generally as remuneration

to them for their work. It would be in addition of the interest mentioned under (8) above.

4. It is obvious that the possible success of such a system depends entirely upon the availability of firms of sufficient standing and repute, and with a sound knowledge of the scientific exploitation of forests; but it is believed that such firms do now exist, as a result of the 15 years or more experience of the system of selling trees standing to purchasers.

5. A possible difficulty standing in the way of the introduction of such a system is that there may be few firms possessing sufficient capital to be able to finance their work without borrowing from third persons; if this were the case, few firms would consider the rate of interest on money expended on the work sufficient, since, generally speaking, they could not raise money in the market for a lower rate of interest than 9 per cent. But, seeing that the proposed system gives no monopoly of *trade* in timber to any individual firm (since Government will be the holder of the timber), there could apparently be no objection to one or two firms undertaking such work, in a whole province, and it is practically certain that a limited number of firms possessing capital of their own would be available in any province in India. Besides, in time, the system would probably attract, into partnership with experienced firms, men with capital, once the profits realizable from such work became a matter of more general knowledge.

6. It is quite obvious that the suggested system would only be applicable to forest regions where timber exploitation gives moderately large returns, since no firm would sink their money in a concern which did not show a reasonable chance of adequate profit. But, in this respect, the system is not at a disadvantage when compared with the present system of sales of standing trees to purchasers; for, under the latter system too, it is impossible to dispose of standing trees unless there is a reasonable prospect of a fair return on outlay.

7. One of the most difficult points to decide under the suggested system would be the proportion of the profits which should go into the pockets of the firm. In view of the fact that

Government would be paying a fair rate of interest on outlay each year, that capital outlay incurred by the firm would be repaid, *as far as possible*, annually out of receipts from sales, so that excessively large sums would not be invested for long periods without any return, and that the firm would draw their percentage of profits (if any) annually, it would not be necessary to guarantee the firm any exorbitant share of the profits. However, what would be considered a good return from an investment in Europe, would hardly be so regarded in India by the ordinary commercial man, so that the share of profits could not, in all probability, be pitched very low. As a basis for discussion, it is suggested that 10—12½ per cent. would be fair.

8. The procedure in arranging for such a contract, as has been outlined above, would be simple : it would merely be necessary to call for tenders, after stating the main terms of the agreement under which a firm would be required to work somewhat on the following terms :—

" $\frac{\text{I}}{\text{We}}$ ______________, *resident of* ______________, *having* acquainted $\frac{\text{myself}}{\text{ourselves}}$ with the conditions upon which a contract for the felling, logging and conversion of (say 10,000) trees from the forests of the ________ Forest Division, and carriage of their outturn to the Forest Department Sale Depôt at __________, do hereby offer to take up the proposed contract on conditions that $\frac{\text{I am}}{\text{we are}}$ paid back $\frac{\text{my}}{\text{our}}$ total outlay in full and (say 10) per cent. of the profits derived from the sale of such outturn, and also receive interest on $\frac{\text{my}}{\text{our}}$ outlay at the rate of interest at which Government can borrow money, from time to time, always provided that in the event of there being a loss on the business I agree to bear (10) per cent. of such loss.

" Dated ______________ (Sd.)______________

" The ______ ______________ Address ______________ "

9. An imaginary account of the working out and sale of the outturn of 10,000 deodar trees is appended to this article, in which

it is assumed that Government pays the firm 5 per cent. on their annual outlay, and that the firm takes 10 per cent. of the excess of receipts over expenditure. The account is, doubtless, an optimistic one and, at the same time, it has been assumed, for simplicity's sake, that the wood is cut, brought to market and disposed of within one financial year (a very unlikely state of affairs in practice). Nevertheless, it shows roughly how the suggested system would work and that the firm would probably be well repaid by such a contract, while Government would undoubtedly score largely in royalties. For an expenditure of roughly 6 lakhs, the firm gets roughly 1½ lakhs return (interest on outlay plus share of profits) while Government gets a royalty of roughly Rs. 104 per tree. Of course Government would get back some of the firm's profits in the form of income-tax.

10. It can, it is believed, be claimed for the system that it has the following advantages :—

(1) It does not discourage private enterprise, and discounts the criticism that it is not the function of Government to enter the market as a timber trader at the expense of such private enterprise.

(2) It assures a fair share of the profits to Government from their forests, thus benefiting the general public and not merely a few far-sighted individuals.

(3) It enables the Forest Department to keep in touch with the timber market, and so to judge of the requirements of that market at first hand.

(4) It obviates the necessity for the recruitment of a separate body of Government officials to form a Commercial Branch of the Forest Department, while leaving technical officers as free as under the existing system for technical work.

(5) It is not much more complicated to work than the present system of sales of standing trees to purchasers on the royalty basis.

APPENDIX.

THEORETICAL ACCOUNT OF TIMBER EXPLOITATION PROJECT.

Expenditure.

A. By Firm (repayable by the Forest Department) :—

	Rs.	a.	p.	Rs.	a.	p.
(1) Lopping, felling, logging and conversion into 500,000 broad gauge sleepers of 10,000 Deodar 30″ and over in diameter @ Rs. 30 per hundred broad gauge sleepers	1,50,000	0	0			
(2) Carriage of 500,000 broad gauge sleepers from forest to river bank @ annas 6 each ...	1,87,500	0	0			
(3) Floating, rafting and landing 500,000 broad gauge sleepers at the Forest Department Sale Depôt @ annas 5 each	1,56,250	0	0			
(4) Salaries, T.A., etc., of Establishment employed by the Firm	75,250	0	0			
(5) Loss on "Godown," etc.	3,000	0	0			
(6) Miscellaneous expenses	8,000	0	0			
				5,80,000	0	0

B. By Forest Department :—

	Rs.	a.	p.	Rs.	a.	p.
(1) Marking and numbering, etc., 10,000 Deodar-trees	500	0	0			
(2) Controlling and supervising charges ...	24,750	0	0			
(3) Handling, etc., of 450,000 broad gauge sleepers at Sale Depôt @ anna 1 each	28,125	0	0			
(4) Advertisements, correspondence, etc., etc. ...	1,625	0	0			
(5) Interest @ 5 per cent. per annum on Firm's Outlay of Rs. 5,80,000 *(payable to the Firm)*	29,000	0	0			
				84,000	0	0
Total Expenses				6,64,000	0	0

Receipts (assuming loss from all causes of 50,000 broad gauge sleepers) :—

	Rs.	a.	p.
(1) Sale of 75,000 selected deodar broad gauge sleepers @ Rs. 6 each	4,50,000	0	0
(2) Sale of 225,000 1st class broad gauge sleepers @ Rs. 4-8 each	10,12,500	0	0
(3) Sale of 100,000 inferior broad gauge sleepers @ Rs. 3 each	3,00,000	0	0
(4) Sale of 50,000 rejected broad gauge sleepers and pieces @ Re. 1-4 each	62,500	0	0
Total Receipts ...	18,25,000	0	0
Excess of Receipts over Expenditure	11,61,000	0	0

10 % share of profits payable to Firm	Rs.	1,16,100
90 % share of profits creditable to Forest Department	,,	10,44,900
Return to Firm ($\frac{1}{10}$th share of profits and interest on outlay)	,,	1,45,100 = (say) *25* %

Royalty on 10,000 trees = Rs. 10,44,900 = *Rs. 104 (say).*

THE UNSOUNDNESS IN SAL IN CHOTA NAGPUR AND ORISSA.

BY G. M. COOPER, I.F.S.

It is extremely rare, in the exploitation of Sal forests in Chota Nagpur and Orissa, to find consistent soundness in the trees cut over any considerable area. Unsoundness is always present in a greater or less degree. In places it may be very slight, perhaps under 5 per cent. of the trees cut; whereas, in other areas, up to 70 per cent. of the fellings prove to be unsound or hollow, in a greater or less degree, affecting very greatly the yield in sleepers or logs. This unsoundness practically always starts at the base of the tree, and proceeds upwards: it may only be a slight defect or rottenness proceeding a foot or so up the stem, or larger and proceeding correspondingly further, or, in the worst cases, a total hollowness, with only a thin shell of bark and sap-wood running right up to the crown. Where forests are being worked for sleepers, this unsoundness, even in a very moderate degree, very seriously affects conversion. Only a small hole or defect in the centre may render a tree utterly valueless for sleepers, or, again, where it appears possible externally to cut sleepers from the sides of a log omitting the centre portions, it too often happens that the defect does not run true and, after sawing, the sleepers are found to be unsaleable as such, and are consequently rejected. Where sawyers are paid by contract on sleepers passed only (which is the general rule), they thus get nothing for their exertions, and are extremely chary of touching such timber. In case of log extraction, a small defect does not make removal entirely unprofitable, but it very considerably lowers the value of the logs, and anything at all large prohibits export entirely.

In some parts of the Orissa Feudatory States, this unsoundness runs to from 50 per cent. to 70 per cent. of the trees marked and felled, and the loss on sleeper conversion is, therefore, enormous. *In Singhbhum, in places, the percentage is high but it appears to* be, on the whole, not nearly so bad there.

Many reasons have been given for its cause and origin, perhaps the most universal being that of fire. The following are some possible causes :—

(*a*) *Soil Quality*.—The writer has often noticed that, on a rocky hill-side with a shallow soil, unsoundness is very prevalent, while below, in the valley on deeper soil, it becomes much less marked and, even on the same slope, higher up above the bad zone, with a slight increase in soil depth and often a rather different rock formation, also considerable improvement (this is a strong refutation of the fire theory) and his theory is as follows. In the seedling stage, the Sal's first energies are directed in sending down a tap-root, to reach a more or less permanent water-supply, and, with sufficient soil depth, it is able to do this, the growth of the tap continuing with that of the whole tree. On a rocky soil, this tap-root at first grows and thickens but, sooner or later, is unable to proceed, and cannot supply the moisture needed. Lateral root growth is therefore developed and the tap-root, being unable to function, dies off and rots back, and this rot once started proceeds year by year up the centre of the tree. This would explain adequately the worst forms of unsoundness.

(*b*) Fire is, perhaps, the most commonly stated cause, but many timber contractors ridicule this, pointing out that, in virgin Sal forests, burnt over from time immemorial, they have cut magnificent and perfectly sound trees.

(*c*) Erosion, combined with fires, appears a more probable cause. The soil is often washed away from lateral

roots, leaving them bare and exposed, and thus very liable to damage by ground-fires. Rot sets in and where noticed, in these lateral roots more often than not, it is found that the stem is also affected similarly.

(*d*) *Wild Animals.*—Where elephants are common, the writer has seen Sal poles, and trees up to 4 feet girth, from which the bark has been stripped or tusked off from close to the ground to 5′—6′ up the bole, which must cause subsequent flaws and unsoundness, but this cannot be considered as a general cause.

(*e*) *Fungi.*—It is possible that, in the first instance, the unsoundness is caused by a root fungus but, in the majority of cases, this is not apparently a primary cause, though invariably a secondary one.

Thorough investigation of this point, on scientific lines, would be most interesting, and of the greatest value. Experts have recently been tackling the question of Sal regeneration methods, and the best silvicultural systems for working Sal forests, but having got our regeneration we would like to know how to maintain soundness to maturity.

THE UNSOUNDNESS OF SAL.

BY H. H HAINES, I.F.S.

The question of the unsoundness of Sal, in the Sambalpur Division, was put forward by Mr. Mudaliar as a subject for special research, previous to the meeting of the Board of Forestry in 1916. It was not taken up and, I think, rightly so, for the reasons that the unsoundness of the bulk of the existing old crop is, in my opinion, sufficiently obvious for purposes of present working and that until these supposed causes of unsoundness have been tested and found insufficient, the time of a special research officer can be better spent in other directions. These causes have been mostly indicated by Mr. Cooper, but it seems to me that he does not lay sufficient stress on the fact that we are felling *physiologically old*

trees. A Sal tree of, say, 5 feet girth, in a valley with rich soil, and which has otherwise been grown under favourable conditions, is not only actually much younger than one of the same girth on the hills, but a tree of 50 years old in the valley is physiologically much younger, and has a far greater expectation of a hale and sound old age, than one of 50 years old grown under less favourable conditions. Mr. Cooper states that 50 to 70 per cent. of the marked trees are unsound in the Feudatory States. In Sambalpur, we even *find that over 80 per cent. of the marked trees* are unsound in some coupes, but seeing that the exploitable girth is fixed at 6 feet, only unsound or otherwise defective trees being felled under that girth, this only indicates that, under the conditions under which the existing crop has grown up, the time taken to reach 6 feet represents a period of years exceeding the silvicultural rotation, which should be that rotation at which the trees begin to be physiologically old. In future, therefore, unless we can radically alter these conditions, we must adopt a shorter rotation than our 6 feet tree represents, and fell at some lower girth. Many of these conditions, however, can, I think, be altered. Of the various conditions enumerated, which produce early decay, it has to be recollected that age and decay form a vicious circle of cause and effect; so that we cannot always discern whether the lower vitality of the old tree leads to the decay first, or the attacking fungi first lower the vitality and produce the signs of age. Of these conditions enumerated, I would place (of course within the limits of its distribution) his *Soil Quality* first, only if he combines soil quality—as he implies, but does not specifically assert—with *conditions of moisture*. So far as I know, after a study of the subject in practically every region where Sal grows, the composition of the underlying rock has very little influence on growth although the manner in which it throws off or allows the percolation of the sub-soil water, or deflects roots, has a considerable influence. At one time, it was believed that Sal did not grow on Trap and Laterite, but I know of excellent Sal forest on such rocks. There are often apparent exceptions. For instance, in parts of the Central Provinces, the Sal forests are almost limited

by the limit of the metamorphic rocks and the hard bedded quartzites; yet broken quartzites, in other districts, grow good Sal. The case of soils is somewhat different, and it is known that Sal tends to avoid clay (including cotton soil), no doubt principally for reasons of moisture and soil aeration. Yet, in such soil between the crevices of numerous rocks, Sal will grow, as the drainage and aeration is sufficient. A particular form of soil appears to be an exceptional case, which not only concerns Sal but many other trees. I allude to the peculiarly barren condition of certain tracts of country bordering on some nalas. These tracts are much broken up with smaller nalas and ravines, there is much denudation, and the soil apparently largely impregnated with lime which often appears on the surface in the form of 'kunkar' nodules. What is the cause of the barrenness? I presume the presence of the lime must be due to the decomposition of certain soda-lime felspars, as the conditions are especially frequent in gneissic, granitoid and trappean rocks but, even if so, why should the lime chiefly affect these localities, and why should such barren tracts with kunkar often occur on deep cotton soil, not associated with underlying trap, and even on some sandstones and quartz schists? If the rapid evaporation of the percolated water, in such places, is the cause of the large deposit of lime, what *originally* caused the barrenness that is now the cause of the evaporation? The tracts are often in localities not likely to have been jhumed. Further, is the lime itself chemically inimical to the growth of so many species of trees, or is it the effect in clogging all the pores in the soil or the resultant intense hardness? It is unlikely to be the lime in its chemical aspect, as many tracts with underlying limestone are not so affected.*

To return to Mr. Cooper's discussion: it is clear from his theory of the decay of the tap-root that he also is concerned with soil quantity, and the mechanical action of the underlying rock, and not really with 'soil quality,' except in so far as depth is a quality of soil. It is certainly a plausible theory that the decay

* NOTE.—Since writing this I see that Mr. Hole in his "Œcology of Sal" also found that lime was inimical to seedlings but I do not think he quite shows how.

may start with the tap-root, and it is one that could only be determined by research, but we cannot alter the radical conditions of our locality and we should be no nearer growing sound Sal trees on dry rocky hills, after proving the theory, than we were before. I think, therefore, it is more important to consider those other conditions under which our present Sal crop has grown up. In doing so, we shall come to the conclusion that these conditions can be considerably improved in localities where soil and moisture are adequate.

The greater part of the open fertile valleys have been jhumed at some time or other, and the young crops have grown up without any attention, often matted with creepers, and damaged by wild elephants and bison but, omitting the consideration of jhumed areas, the old crop is either virgin or it has been worked. If virgin, the greater number of the old trees are, of necessity, over-mature, and the younger trees have grown up more or less completely dominated by the old ones, as well as by creepers. If worked, the working has always consisted in removing the best and soundest trees or the straightest poles, no attention has been given to thinnings, to the removal of dominating bad Sal, inferior species or bamboos or to the cutting of climbers. Broken saplings have never been cut back but, on the contrary, stems have continually been hacked off some feet above the ground and branches hacked and broken, and finally trees have often been tapped for resin. All these conditions are remediable. Again, in some Sambalpur forests, the Loranthus is a terrible pest; but, with careful working, the effect of this can also be greatly reduced or eliminated in future crops. In addition to these conditions, fires have frequently occurred in the hottest time of the year. The bad effect of fires is said to be ridiculed. But the truest theses are often ridiculed by the ignorant, and the fact that sound Sal trees have been cut from forests which have been burnt is no argument that severe fires cannot indirectly produce unsoundness. In the damper and most fertile valleys, where the 'magnificent and sound Sal' trees have been cut, the conditions are often such that fires will not do harm. They may even do

good. I have even seen such valleys where fires have not been able to penetrate in the hot season. It is in less fertile localities, where continued fires produce a strong growth of grass, and will burn poles and saplings in such a way that the top, for many feet, dies back and gets broken off in the next high wind that unsoundness may set in, not from the fire itself but from the seeds of decay which enter the torn and broken stump of the already weakened sapling.

Then, as regards the growth of the grass itself, another effect of fires, I believe this grass most inimical to good Sal growth. In many of our valley forests, where grass has been enabled to take possession of the soil, not only do the trees show exceedingly poor growth, and grow *stag-headed*, but reproduction is practically absent. The letting in of more light, as in regeneration fellings, does not help matters, but probably make them worse by increasing the growth of the grass. It has already been proved, in the case of fruit trees, how toxic is the effect of grass on the soil, and here, I believe, we have the explanation of the want of regeneration in such grassy areas of our Sal forests. A recent article on this subject by Professor Somerville (*Indian Forester*, February 1917) on the growth of young Ash trees is particularly interesting in this connection and, to obtain regeneration in such areas, we should try exposing the soil to the air and prevent the regrowth of the grass.

Then, again, we have trees actually killed by drought, as has been demonstrated almost to proof in the last few dry years (omitting the current one, in which the rainfall has been abundant and trees have not died). Where not killed outright, the tops have often dried off, and such condition of drought must assuredly be aggravated by a forest fire.

Such being the effects of fires and too much light and drought, I will again refer to the opposite effects of too much damp and darkness. In Central India, the condition of too much damp is rare in well-drained forests, but is common in Bengal and frequent in Bihar and Orissa. To it is ascribable the ravages of the fungus ***Polyporus Shoreæ*** which has increased, to such an alarming extent,

in the absence of fires in the Duars. This fungus is also frequent in Orissa, and has been found in other parts of the province but, in Orissa, we have another fungus which I will call the 'Sal-thicket fungus,'* first, I believe observed by Mr. Comber in Angul in the rains of 1916. I say *another* fungus, but this is rather a bold statement to make in the case of fungi, when the sporocarp of a particular form has not yet been discovered. This form or species is not apparently a root-fungus but the mycelium appears on the young stems and branches and spreads on to the leaves. In older parts, it assumes the form of thicker white strands and bands. It often appears to originate near a wound caused by the breaking of a branch, the leaves turn brown and die, branches die off and break away at the stem or the whole top dies and breaks off. Ultimately, after many attempts at putting out new shoots, which causes a characteristic nodose appearance of the stem, the whole plant may die. This dying back and breaking off of the branches may be the cause of the fungus appearing to originate at wounds. Now, the great point about this fungus, which makes its mention especially relevant here, is that it always appears in over-crowded thickets, or on saplings under the shade of bamboos, or in other places where light is apparently insufficient; and it may, therefore, I think, be rightly classified among those bad conditions producing unsoundness which can be removed by future treatment. Improvement Fellings, Thinnings and Cleanings seem to be the remedy and, in grave cases, almost certainly, fire and coppice.

Improvement Fellings have not always, however, the effects looked for, and Messrs. Dodsworth and Kirkpatrick report that the effect of such fellings, in some cases in Singhbhum, is to produce the dying off of the freed Sal trees. They are investigating this aspect of the case. Such exceptions, notwithstanding, on the whole, I think, it may be safely said that scientific treatment of our future Sal crop will very largely remove those adverse conditions which have given rise to a great bulk of the present unsoundness. In those localities which, so far as conditions of moisture and depth of soil go, are entirely unsuitable for Sal, we cannot expect

* Specimens were sent to Dehra in 1916.

to grow good Sal any more than we can expect to grow many other trees. Even in some of these cases, depth of soil in the ordinary sense is not required if the underlying rock is sufficiently fractured.

INDIAN SPECIES OF *GREWIA* OF FOREST IMPORTANCE.

BY R. S. HOLE, FOREST BOTANIST.

Systematic study of *Grewia* species a matter of economic importance.

1. Some Indian species of *Grewia*, e.g., *G. tiliæfolia*, Vahl, are of considerable economic value on account of the elasticity and toughness of their wood and their wide distribution in our Indian forests. Other species, on the contrary, yield wood which is only fit for fuel or are mere shrubs of no economic importance. The satisfactory identification of the various species, however, is at present practically impossible owing to the great differences of opinion which prevail among botanists as to the limits of the different species, and to the consequent lack of accurate descriptions and illustrations of the species. To illustrate the confusion which exists regarding the forms which are of greatest forest importance it may be noted that, in Hooker's *Flora of British India*, I, pp. 385—387, 1874, while *G. tiliæfolia*, Vahl., is kept as a distinct species, the typical form of the species is excluded from the description, that both *G. vestita*, Wall., and *G. elastica*, Royle, are included in the totally distinct and comparatively valueless *G. asiatica*, Linn., that the Burmese tree *pintayaw* (= *G. excelsa*, Roxb.) is identified—(1) with *G. excelsa*, Vahl., which is an Arabian plant and (2) with *G. salvifolia*, Roxb., which is a comparatively valueless shrub. In this work also *G. orbiculata*, Rottl., and *G. rotundifolia*, Juss., are included in one species.

Duthie (*Flora of the Upper Gangetic Plain*, Part I, p. 113, 1903) maintains *G. vestita*, Wall., and *G. elastica*, Royle, as distinct species, while he describes a plant under the name of *G. asiatica*, which is not *G. asiatica*, Linn.

Brandis, on the other hand (*Indian Trees*, p. 58, 1908), unites in a single species (which he calls *G. asiatica*, Linn.), *G. vestita*

Wall., *G. elastica*, Royle, *G. tiliæfolia*, Vahl., and the Burmese *pintayaw*; he separates as distinct species *G. rotundifol a*, Juss., and *G. orbiculata*, Rottl., and creates a new species which he calls *G. leptopetala*.

Finally, the small shrub *G. sapida*, Roxb., has been brought into this confused complex by some botanists mistaking it for *G. asiatica*, Linn., or *G. subinæqualis*, DC.

The above remarks suffice to indicate the confusion which at present prevails regarding the definition of the Indian *Grewias* of most forest importance and it is obvious that the economic value of the species cannot be fully realized until accurate descriptions and illustrations are available which will enable the important species to be readily identified and distinguished from others of comparatively little value. As a careful systematic study of these species was, therefore, of obvious economic importance the subject was included in the programme of work prescribed for the Forest Botanist.

Necessity for study of the species by a field botanist in India.

2. At the commencement of this study there was a tendency in some quarters to consider that, although this subject was undoubtedly of economic importance, it was one which should be dealt with rather by an expert herbarium systematist, many of whom are available in the great European herbaria, rather than by a so-called Economic Forest Botanist. In the writer's opinion, although a knowledge of the available herbarium material and of type specimens must form the basis of systematic work on any particular group, a final decision regarding the limits of species can only be reached by field study and experimental cultures.

A remarkable fact which must strike any student who attempts a classification of the Indian *Grewias* from herbarium specimens alone is this, *viz.*, that while a superficial study, dealing with comparatively few specimens, will reveal a number of well-marked types which appear to be thoroughly good species, further study dealing with longer suites of specimens of each form reveals more or less numerous intermediates which confuse and render indistinct the boundaries between the types. This fact, it is believed, led Brandis

in 1906 (*Indian Trees*, p. 98) to unite in one species three forms which he regarded as distinct in 1874 (*Forest Flora of N.-W. and Central India*, p. 37).

Recent study, however, has made it abundantly clear that if this procedure is consistently followed we can by no means stop where Brandis stopped, and it is probably not going too far to say that there is no single Indian species of the genus regarding which careful study could not produce a complete set of intermediates uniting it with one or more distinct species. In any case, Brandis made it clear that he was not satisfied with his treatment of this genus and that, in his opinion, an ultimate decision was to be reached "not by examining isolated herbarium specimens, but by studying these difficult species in gardens and in the forest" (*Indian Trees*, p. 702).

Lines of work approved by Kew.

3. In order to obtain an authoritative decision from expert systematists as to the advisability of this work being undertaken by the Forest Botanist in India, the writer laid the case before the authorities at Kew in 1909.

In reply to this representation, Dr. Stapf, the Curator of the Herbarium of the Royal Botanic Gardens, Kew, wrote: "Field work on the lines laid down by Mr. Hole is of great importance as a supplement and corrective for herbarium work which is apt to suffer through becoming too narrow and detached from the actual conditions of plant life," while Sir David Prain, Director of the Royal Botanic Gardens, when forwarding this note wrote: "With Dr. Stapf's remarks I entirely concur. We shall be glad to do whatever is in our power to assist you with photographs or drawings of types or with co-types where types are in existence or co-types are available." In the first place, therefore, the writer desires to thank Sir David Prain and Dr. Stapf most heartily for their encouragement and invaluable assistance, without which this work could not have been carried out.

Scheme of work.

4. The general lines of study have been as follows:—

(*a*) To determine, as accurately as possible, the types which are the authorities for the various published names,

(*b*) To study the herbarium material available in Kew, London, Paris, Calcutta and Dehra Dun.

(*c*) To secure the co-operation of Forest Officers in India and Burma, on as wide a scale as possible, in obtaining specimens of the species from as many localities as possible.

(*d*) To register and number selected trees in the forest and to collect leaves, flowers and fruit at different seasons from one and the same individual tree.

(*e*) To cultivate selected species in the Botanical Garden at Dehra Dun.

(*f*) To study the species carefully in the forest, especially with reference to the occurrence of apparent intermediates, the characters and distribution of the latter and the relative numbers and importance of such intermediates with reference to the main masses of individuals composing the respective species, the boundaries of which they tend to obscure.

Work completed. *G. asiatica* and *G. Hainesiana* described in first part of publication.

5. Thanks chiefly to the whole-hearted co-operation of Forest Officers in India and Burma, a unique collection of material has now been brought together at Dehra Dun including living plants of several species in the Botanic Garden which are now of sufficient age to produce flowers and fruit. Work on lines such as these necessarily requires considerable time, and the Forest Botanist is frequently obliged to lay aside systematic work for long periods owing to educational and other duties of greater urgency. As, however, it is obviously desirable that the results obtained should be published with as little delay as possible it has been decided to publish the work in parts, as it is completed, the several parts eventually forming one complete volume of the *Indian Forest Memoirs*. The first part of this work has just been completed with detailed descriptions and illustrations and deals with the following two species:—

I. **Grewia asiatica**, Linn.—This species is usually a large shrub with mature leaves hoary beneath, which, so far as is known

at present, only occurs in India in gardens where it is cultivated for its small edible fruit. It is especially common in gardens in the north of the Bombay Presidency, and Linnæus obtained his original specimen from Surat.

II. **Grewia Hainesiana,** Hole, *sp. nov.*

Species cum **G. asiatica,** Linn., *adhuc confusa sed differt præsertim pyrenis* 1—2 *locularibus, drupa majore et foliis adultis subtus non canis.*

This plant is a forest tree, sometimes attaining a height of 50 feet, which is common in the Sub-Himalayan and Siwalik tracts in Northern India and extends to the Satpuras in Central India. It is also widely grown in gardens throughout India and has a large edible fruit. This is the tree which has been more or less correctly described by Kanjilal (*Forest Flora*, p. 66, 1911) and Duthie (*Flora of Upper Gangetic Plain*, p. 113, 1905) but under the name of *G. asiatica*, Linn. This is probably the plant, in part at least, which Roxburgh called *G. asiatica* and is also possibly the *G. subinæqualis*, DC, but this is not certain and, in any case, this latter name has been used by different authors for entirely different species and, being thus liable to cause confusion, should be suppressed. The species has now been named after that excellent botanist H. H. Haines, Esq., Conservator of Forests, who has given the writer the most generous help during the study of this genus, in the way of photographs of, and notes regarding, various type specimens. The most reliable character for the differentiation of these two species appears to lie in the number of cells in the pyrene. In the case of *G. asiatica*, Linn., 51 pyrenes have been examined from plants grown in the Punjab, United Provinces, Sind, Poona and the Central Provinces. In all cases the pyrenes were 1-celled. In the case of *G. Hainesiana*, 89 pyrenes were examined collected from 25 trees grown in the United Provinces, Central Provinces, Bengal, Bombay and Madras. Of these 40 were 1-celled, 48 were 2-celled and one was 3-celled. In the cases of every individual tree, also, the examination of at most 4—5 pyrenes sufficed to produce at least one 2-celled pyrene.

6. The work which has been done up to date indicates that, in this genus, there are two main sources of difficulty for the herbarium botanist, *viz* :—

(1) The fact that the flowers of most species are visited by large numbers of bees, and that a more or less considerable amount of hybridization takes place, naturally. For the field botanist the correct diagnosis of natural hybrids is comparatively easy, but the herbarium worker is apt to over-estimate the importance of such individuals which he either regards as intermediate forms justifying the amalgamation of what are really perfectly distinct species, or else separately describes as new and established species.

(2) Many of the species have an exceptional power of producing a vigorous growth of adventitious shoots as a result of coppicing or pollarding or otherwise. Such twigs frequently exhibit characters widely differing from those of the normal twigs, and as they produce flowers and fruit they are commonly found in herbaria and are there a fertile source of confusion. In this connection, it may be noted that whereas, in *G. sapida*, Roxb., the shoots are usually annual and spring from a subterranean root-stock, under protection, these shoots frequently persist and produce lateral flowering twigs which differ from the basal shoots in characters which hitherto have almost universally been considered to be of specific value.

Next instalment of publication to deal with *G. sapida*.

7. The next instalment of this publication will deal with the various forms of *G. sapida*, Roxb., and the hybrids between this species and *G. elastica*, Royle.

SOME NOTES ON SANDAL IN THE SAMBALPUR DIVISION (BIHAR AND ORISSA).

BY A. P. MUDALIAR, P.F.S.

The area of the Reserved Forests of the Sambalpur Division is 400 square miles. Excepting an area of 80 square miles which contains fairly good Sal, the major portion of the forest consists of a poor type of Sal and mixed forests, with or without bamboos.

The forests usually occupy hilly ground, rising from a few hundred to over 2,000 feet.

The underlying rock consists principally of metamorphic rocks, with much quartz, and frequently mica-schists. Over considerable areas south of the Mahanadi, however, are deposits of grits, sandstones and shales; while, in several localities, laterite occurs and kunker limestone. The soil is usually shallow except in valleys. On metamorphic rocks, it varies from a stiff to a sandy loam, often with kunker and quartz stones. On the shales, it is clayey; and, on the grits and sandstones, it is, of course, principally sandy.

The climate is excessively hot in summer, and hot westerly winds generally commence from about March every year. In exceptional years, the forests are liable to drought. The average annual rainfall is about 58 inches. Although the winter is cold, no frosts occur in the forests.

Sandal and its natural habitat.

Sandal is an evergreen tree, and although it grows naturally and thrives well in the dry regions of South India, chiefly in the Mysore Province, Coorg and portions of Madras and Bombay Presidencies, it is probable that it can be grown in many other places, although the chances for its successful growth may be much less than within its natural habitat.

Sandal grows in almost all well-drained soils, and at all elevations from the sea-level up to about 3,500 feet, but beyond this altitude it does not grow well. It is believed, or rather it was the belief, that the Sandal trees grown at low elevations do not produce scented heart-wood and that the best wood, and richest in oil, is grown between 2,000 and 3,000 feet. In the articles written by Mr. Rama Rao headed "Sandal-wood at Kurnool," "Sandal-wood

at Sea-level" and "Sandal-wood at Low Elevations" and published in the *Indian Forester* of August 1906, March and December 1908, respectively, the theory that Sandal trees at low elevations do not produce scented heart-wood has been sufficiently disproved.

Further, in the article entitled "Note on the Oil-value of some Sandal-wood," and published in the *Indian Forester* of April 1915, Mr. Puran Singh, Chemical Adviser to Forest Research Institute, says: "It will be seen that neither elevation, nor age, nor locality has any definite relation with the quality of the Sandal-wood as regards the percentage of essential oil in it." It is said that the trees growing in comparatively good, fertile soil yield heart-wood poorer in essential oil than those growing in poor, rocky, gravelly soils. It is, however, too early to consider this question here.

Dibbling of Sandal in 1913 and its results.

Considering all the above circumstances and factors of the locality, it appeared to me that this Division was more or less suitable for the propagation of Sandal and, intending to try the experiment in the Reserved Forests, I obtained a small quantity of Sandal seed from Mysore and dibbled it during June 1913 in patches, close to the base of the trees or shrubs intended to nurse the future plants. The dibbling was done in selected areas in the Reserved Forests, over a total area of about 20 acres, by the Forest Guards in their respective beats, and practically no cost was incurred on this work. Seeds began to germinate after a month. After six months, there was a large number of healthy plants from 4" to 6" in height. The Conservator of Forests, after inspecting some of these areas in February 1914, made the following remarks in his inspection note:—

"The experiment now being carried on is in connection with Sandal. The Divisional Forest Officer has had considerable experience of the species in other Provinces, and having imported some seed has had it dibbled, in suitable places throughout the reserves, by the beat officers. The seedlings have generally germinated very well, and if they continue to thrive, will add enormously to the value of the forests, while if they ultimately fail, the cost has been practically nil."

Some seeds were also dibbled in the compound of the Sambalpur Town Hall. In the first week of August 1916, I noticed a plant bearing flower buds, while in other plants no inflorescence was observed. The height of the above plant is now 10 feet, and it has developed a very healthy crown which has pushed itself through the crown of its host (*Plumeria acutifolia*).

A few seeds dibbled in the open behind the Forest Office, on the slope of the hill where the soil is poor and stony, also germinated fairly well. A large number of plants were either destroyed by cattle or dried up during the ensuing severe hot weather. Of the plants surviving, the height of one is about 8 feet, but it has a poor crown and is not very healthy, probably due to its being in the open without any host tree near it.

Both inside and outside the Reserved Forests, there are many established plants, and the height measurements of some of them and the names of their associates are given below :—

Year of dibbling.	Name of block.	No. of plant.	Height.	Associate Species.	REMARKS.
			Ft. in.		
1913	Mundher... ...	1	5 0	*Lagerstrœmia parviflora.*	
		2	4 6	*Terminalia tomentosa.*	
		3	5 10	*Sal (Shorea robusta).*	
		4	5 7	*Terminalia tomentosa.*	
		5	4 4	,, ,,	
		6	4 9	*Sal (Shorea robusta).*	
		7	6 0	*Anogeissus latifolia.*	
		8	5 10	*Sal (Shorea robusta).*	
		9	4 4	,, ,, ,,	
		10	5 1	,, ,, ,,	
,,	Kulchor	11	5 8	*Phyllanthus Emblica.*	
		12	5 0	*Bridelia retusa.*	
		13	4 0	Nil.	

Sandal in the Sambalpur Division.

Fig. 1. Plant in the Lambdungri forest. Dibbling of June 1913.

Photo.-Mecht. Dept., Thomason College, Roorkee. Photo. by R. S. Pearson.

[illegible] of 1914. [illegible] Plant in the Lambdungri forest. Dibbling of 1915.

Year of dibbling.	Name of block.	No. of plants.	Height.		Associate Species.	REMARKS.
			Ft.	in.		
1913	Kulchor ...	14	3	9	*Zizyphus.*	
		15	3	0	Nil.	
		16	2	8	*Anogeissus latifolia.*	
		17	2	6	,, ,,	
		18	2	5	Nil.	
		19	2	5	*Terminalia tomentosa.*	
		20	1	8	,, ,,	
,,	Kandrapat ...	21	4	0	*Anogeissus latifolia.*	
		22	3	1	*Woodfordia floribunda.*	
		23	2	0	,, ,,	
		24	2	0	*Phyllanthus Emblica.*	
		25	1	7	*Adina cordifolia.*	
,,	Debrigarh ...	26	6	6	*Anogeissus latifolia.*	
		27	6	6	*Terminalia tomentosa.*	
		28	4	6	,, ,,	
		29	4	6	*Lagerstrœmia parviflora.*	
		30	4	0	*Terminalia belerica.*	
		31	3	6	*Diospyros Melanoxylon.*	
,,	Dhudherkusam ...	32	6	10	,, ,,	
		33	6	0	*Terminalia tomentosa.*	
		34	5	0	*Sal* (*Shorea robusta*).	
		35	4	6	*Terminalia tomentosa.*	
		36	4	6	*Holarrhena antidysenterica.*	
		37	4	0	*Sal* (*Shorea robusta*).	
		38	3	8	*Anogeissus latifolia.*	
		39	2	0	*Holarrhena antidysenterica.*	
		40	2	0	Nil.	

Year of dibbling.	Name of block.	No. of plants.	Height.	Associate Species.	REMARKS
			Ft. in.		
1913	Chandlidungri ...	41	4 2	*Anogeissus latifolia.*	
		42	3 6	*Terminalia belerica.*	
		43	3 6	Nil.	
		44	3 0	*Buchanania latifolia.*	
		45	3 0	*Diospyros Melanoxylon.*	
		46	3 0	Nil.	
		47	2 6	,,	
		48	3 7	*Diospyros Melanoxylon.*	
		49	2 7	*Soymida febrifuga.*	
		50	2 1	,, ,,	
		51	2 1	*Lagerstroemia parviflora.*	
		52	2 1	Sal (*Shorea robusta*).	
		53	1 11	*Diospyros Melanoxylon.*	
,,	Sambalpur Town Hall compound.	54	10 0	*Plumeria acutifolia.*	
		55	5 6	,, ,,	
,,	Lambdungri ...	56	7 9	*Butea frondosa.*	
		57	7 0	*Terminalia tomentosa.*	
		58	6 3	,, ,,	
		59	6 1	,, ,,	
		60	5 2	,, ,,	
		61	3 11	*Buchanania latifolia.*	
		62	3 9	*Bassia latifolia.*	
		63	3 9	*Eugenia Jambolana.*	
		64	7 10	Nil.	

Dibbling of 1914 and its results.

The operation of 1913, which was started on a small scale, gave satisfactory results, and a large percentage of seedlings which survived the hot weather

were, on an average, about 2 feet in height in March 1914. About 100 seers of seed were obtained, and dibbled during May and June 1914, in the same way as was done in the previous year, in different places of the Reserved Forests, over an aggregate area of about 100 acres. The germination, in most of the areas, was good, but as the Sandal has more than its fair share of enemies, a large number of seedlings, soon after germination, was destroyed by rats, squirrels, jungle fowl and pigs, and those that escaped such destruction were fenced by putting thorns round the patches, to protect them from being eaten by deer and cattle. As forest fires are also very destructive, a line was cut and cleared around each plot. Mr. Carter, Conservator of Forests, inspected some of these areas in January 1915 and made the following remarks in the inspection note :—

"The sowing of Sandal is being continued with varying results. In Lambdungri, both this and last year's plants have done well and look healthy, some of them being over 2 feet high. This area has been too heavily grazed and, with the added danger to the Sandal plants, it must be closed. The Divisional Forest Officer should fix the area to be closed and, in addition to informing the villagers, should put up a few notice-boards. The Sandal sown north and east of Larasara has not done at all well, and the localities chosen seem unsuitable, probably too cold and damp. The seedlings near Mundher were good, and the experiment which was initiated by the Divisional Forest Officer seems to be justifying itself, but it is no use continuing to sow where the plants are unhealthy, or do not germinate freely."

The following statement gives the height measurements of some of the plants of 1914, together with the names of their associates :—

Year of dibbling.	Name of block.	No. of plants.	Height.	Associate Species.	REMARKS.
			Ft. in.		
1914	Mundher .	1	3 0	*Lagerstrœmia parviflora.*	
		2	1 8	,, ,,	
		3	1 9	,, ,,	
		4	1 11	*Anogeissus latifolia.*	
		5	1 10	*Lagerstrœmia parviflora.*	
		6	1 8	*Terminalia belerica.*	
		7	1 7	,, *tomentosa.*	
		8	1 7	,, ,,	
		9	2 8	,, ,,	
,,	Kulchor	10	2 7	Sal (*Shorea robusta*). } Forest Rest House compound at Badsair.	
		11	5 5	*Kigelia pinnata.* } Forest Rest House compound at Badsair.	
		12	5 1	,, } Forest Rest House compound at Badsair.	
		13	4 8	*Soymida febrifuga.*	
		14	4 0	*Terminalia tomentosa.*	
		15	2 8	,, ,,	
		16	2 5	,, ,,	
		17	2 0	Nil.	
		18	1 9	*Terminalia tomentosa.*	
		19	1 8	Nil.	
		20	5 1	*Anogeissus latifolia.*	
		21	3 2	*Terminalia tomentosa.*	
		22	3 0	Sal (*Shorea robusta*).	
		23	2 9	,, ,, ,,	

Year of dibbling.	Name of block.	No. of plants.	Height.	Associate Species.	REMARKS.
			Ft. in.		
1914	Kandrapat ...	24	2 0	*Woodfordia floribunda.*	
		25	1 3	*Holarrhena antidysenterica.*	
		26	1 0	*Anogeissus latifolia.*	
		27	1 0	,, ,,	
		28	1 0	*Lagerstrœmia parviflora.*	
,,	Larasara Rest House compound.	29	9 3	Jasmine.	
		30	7 8	,,	
		31	7 6	,,	
		32	7 0	,,	
		33	6 6	,,	
		34	6 0	,,	
		35	5 10	,,	
		36	5 9	,,	
		37	5 7	,,	
		38	5 0	,,	
		39	4 0	,,	
		40	4 3	,,	
,,	Kolgaon Rest House compound.	41	3 7	,,	
		42	3 5	,,	
		43	3 1	,,	
		44	2 7	,,	
		45	2 4	,,	
,,	Larasara-Deogaon ...	46	3 8	*Randia dumetorum.*	
		47	3 6	Sal (*Shorea robusta*).	
		48	2 7	,, ,, ,,	
		49	2 6	*Holarrhena antidysenterica.*	

Year of dibbling.	Name of block.	No. of plants.	Height. Ft. in.	Associate Species.	REMARKS.
		50	2 4	*Terminalia belerica.*	
		51	2 0	*Cleistanthus collinus.*	
		52	2 0	*Buchanania latifolia.*	
		53	1 4	Sal (*Shorea robusta*).	
1914	Jaduloising ...	54	3 0	,, ,, ,,	
		55	3 0	*Cleistanthus collinus.*	
		56	2 7	*Terminalia tomentosa.*	
		57	2 6	*Woodfordia floribunda.*	
		58	2 6	,, ,,	
		59	2 6	*Buchanania latifolia.*	
,,	Naktichaper ...	60	1 10	*Anogeissus latifolia.*	
		61	1 9	,, ,,	
		62	1 7	*Diospyros Melanoxylon.*	
		63	1 4	*Buchanania latifolia.*	
		64	5 2	Sal (*Shorea robusta*).	
		65	4 2	,, ,, ,,	
		66	4 0	,, ,, ,,	
		67	3 4	,, ,, ,,	
		68	3 1	,, ,, ,,	
		69	2 7	,, ,, ,,	
		70	2 2	,, ,, ,,	
,,	Lohera ...	71	1 9	*Lagerstrœmia parviflora.*	
		72	1 7	*Terminalia Chebula.*	
		73	1 3	*Diospyros Melanoxylon.*	
		74	1 2	,, ,,	
		75	2 7	Sal (*Shorea robusta*).	
		76	2 5	*Pterocarpus Marsupium.*	

Year of dibbling.	Name of block.	No. of plants.	Height.	Associate Species.	REMARKS.
			Ft. in.		
		77	2 5	Sal (*Shorea robusta*).	
		78	2 5	,, ,, ,,	
		79	2 3	*Buchanania latifolia.*	
		80	2 0	Sal (*Shorea robusta*).	
1914	Debrigarh ...	81	6 6	*Holarrhena antidysenterica*	
		82	5 5	*Dalbergia paniculata.*	
		83	5 0	Sal (*Skorea robusta*).	
		84	4 6	,, ,, ,,	
		85	4 0	*Strychnos potatorum.*	
		84(a)	4 6	,, ,,	
		85(a)	4 0	,, ,,	
		86	4 2	,, ,,	
		87	4 2	*Terminalia belerica.*	
		88	4 0	*Holarrhena antidysenterica*	
		89	3 6	*Diospyros Melanoxylon*	
		90	3 6	*Stereospermum suaveolens.*	
		91	3 4	*Terminalia belerica.*	
		92	3 3	Sal (*Shorea robusta*).	
		93	3 0	*Schrebera swietenioides.*	
		94	3 0	Sal (*Shorea robusta*).	
		95	3 0	Bamboo.	
,,	Dhoderkusam ...	96	3 4	*Terminalia tomentosa.*	
		97	2 7	*Pterocarpus Marsupium.*	
		98	1 6	Sal (*Shorea robusta*).	
		99	2 6	*Buchanania latifolia.*	

Year of dibbling.	Name of block.	No. of plants.	Height.	Associate Species.	REMARKS.
			Ft. in.		
1914	Chandlidungri ...	100	1 6	*Terminalia tomentosa.*	
		101	2 3	*Diospyros Melanoxylon.*	
		102	2 0	*Cleistanthus collinus.*	
		103	2 0	*Acacia Catechu.*	
		104	2 0	*Buchanania latifolia.*	
,,	Kudopali ...	105	5 0	,, ,,	
		106	2 11	*Diospyros Melanoxylon.*	
		107	2 7	*Zizyphus.*	
,,	Sambalpur Town Hall compound.	108	4 6	Bamboos.	
,,	Lambdungri ...	109	3 10	*Soymida febrifuga.*	
		110	3 5	*Anogeissus latifolia.*	
		111	3 3	*Terminalia tomentosa.*	
		112	2 10	*Holarrhena antidysenterica.*	
		113	2 9	*Casearia tomentosa.*	
,,	Lachmidungri ...	114	4 5	*Diospyros Melanoxylon.*	
		115	3 1	*Cleistanthus collinus.*	
,,	Lamal-junan ...	116	2 7	*Buchanania latifolia.*	
		117	2 2	*Bassia latifolia.*	
,,	Jamra	118	2 0	,, ,,	
		119	4 0	*Diospyros Melanoxylon.*	
		120	2 0	*Terminala Chebula.*	
,,	Bhowerkhol ...	121	2 10	*Acacia Catechu.*	
		122	2 6	*Anogeissus latifolia.*	
		123	2 4	,, ,,	
		124	4 9	*Buchanania latifolia.*	

Year of dibbling.	Name of block.	No. of plants.	Height.	Associate Species.	REMARKS.
			Ft. in		
1914	Budharaja ...	125	5 9	*Butea frondosa.*	
		126	4 0	Nil.	
		127	4 0	*Cleistanthus collinus.*	
		128	3 10	,, ,,	
,,	Ghichamura ..	129	3 10	*Phyllanthus Emblica.*	
		130	2 11	,, ,,	
		131	2 0	Sal (*Shorea robusta*).	
,,	Jharghatti ...	132	3 6	*Terminalia tomentosa.*	
,,	Sangramal ...	133	4 9	*Cleistanthus collinus.*	
		134	2 8	,, ,,	

In 1914, some seeds were also dibbled close to the jasmine plants, in the compound of the Larasara forest bungalow. The seeds germinated well, and the plants are now 8 to 10 feet in height and are very healthy. At the same time, some seeds were also dibbled under bamboos, along the fence of the Town Hall compound at Sambalpur. They are also now in good condition, and appear healthy.

In March 1915, as a result of the sowings of 1913 and 1914, there were not less than 10,000 plants in the different plots, giving an average of about 80 plants per acre but, on account of the exceptionally dry and hot weather, and also, due to the hot, dry westerly winds, which generally prevail throughout the summer months, a large number of plants dried up during April and May. Moreover, in the high forest, where the growth was dense, the plants did not thrive so well as they did in other forests which were rather open.

Notwithstanding the above conditions, in June 1915, when the plants were counted, it was noticed that a large percentage of plants had survived. It was also noticed that the plants, on the

eastern and northern slopes of hills, gave better results than those on the western and southern aspects, and the seeds dibbled, on the east of host trees, looked better than those which were dibbled on the other sides. This is probably due to the plants, on the eastern and northern aspects, and eastern side of the host trees, getting better protection against the hot westerly wind during summer.

The approximate number of established plants, at the end of June 1915, was about 3,000 varying from 1 foot to 4 feet in height. Had it not been for the exceptionally dry weather of the year, a larger number of plants would have survived the hot weather.

Dibbling of 1915 and its results.

During May and June 1915, the dibbling operations were continued, and seeds were sown in about 50,000 patches, over an area of about 150 acres. This included about 80 acres of old and 70 acres of new plots. Some of the plots were inspected by Mr. Haines, Conservator of Forests, in February 1916, who made the following remarks in the inspection note :—

" Mr. Mudaliar, who is intimately acquainted with Mysore, is taking considerable interest in the introduction of Sandal into the Sambalpur forests and, as far as can be at present seen, with some success."

" There are a large number of plots, in different position, scattered through the reserves, and the seed was sown in May and June 1914 and 1915, so that they are now either 6 months or 18 months old.

" The 6 months' plants are 4—6 inches high, and 18 months' plants 2—4 feet high. The general results of the experiments, so far as they go, are :—

(1) In high forest, the plant does not thrive well, especially where dense. It succeeds best in rather open forest of small height-growth.

(2) The soil is not very important but the growth is best on loam. The best I saw was on a well-drained spur with loamy soil.

(3) At this stage, at any rate, the host plant is of small importance. Indeed, it was impossible to discover that the nature of the host had any effect whatever on the growth of the plant. The experiments are being carried on practically, without cost, with seed sent from Mysore."

The following statement gives the height-measurements of some of the plants of 1915 together with the name of the associates amidst which they are growing :—

Year of dibbling.	Name of block.	No. of plants	Height.	Associate Species.	REMARKS.
			Ft. in.		
1915	Mundher... ...	1	1 4	*Terminalia tomentosa.*	
		2	1 0	*Cleistanthus collinus.*	
		3	1 0	*Terminalia tomentosa.*	
		4	1 0	*Butea frondosa.*	
		5	1 0	*Lagerstrœmia parviflora.*	
,,	Kulchor	6	3 2	*Lawsonia alba.*	Badsair Rest House compound.
		7	3 0	,, ,,	
		8	4 0	,, ,,	
		9	2 7	,, ,,	
		10	2 6	,, ,,	
		11	2 6	,, ,,	
		12	2 4	,, ,,	
		13	2 5	,, ,,	
		14	2 3	,, ,,	
		15	1 7	*Holarrhena antidysenterica.*	
		16	1 6	,, ,,	
		17	1 5	*Pterocarpus Marsupium.*	
		18	1 4	,, ,,	

Year of dibbling.	Name of block.	No. of plants.	Height.	Associate Species.	REMARKS.
			Ft. in.		
1915	Kandrapat ...	19	1 0	*Terminalia tomentosa.*	
		20	1 0	,, ,,	
		21	1 10	*Anogeissus latifolia.*	
,,	Larasara-Deogan ...	22	1 11	*Terminalia Chebula.*	
		23	1 5	,, ,,	
		24	1 7	,, ,,	
		25	1 4	,, ,,	
,,	Lahdera	26	1 7	*Phyllanthus Emblica.*	
		27	1 7	*Buchanania latifolia.*	
		28	1 7	Nil.	
		29	1 7	*Diospyros Melanoxylon.*	
		30	1 5	*Phyllanthus Emblica.*	
		31	1 4	*Anogeissus latifolia.*	
,,	Papanga	32	3 0	*Diospyros Melanoxylon.*	
		33	1 6	,, ,,	
		34	1 6	,, ,,	
,,	Jaduloising ...	35	1 0	*Terminalia tomentosa.*	
		36	1 0	Sal (*Shorea robusta*).	
		37	1 0	*Butea frondosa.*	
,,	Malaikhaman ...	38	1 0	*Terminalia Chebula.*	
		39	0 10	*Terminalia belerica.*	
,,	Naktichaper ...	40	1 1	*Dalbergia paniculata.*	
		41	0 10	*Dalbergia Sissoo.*	
		42	1 9	*Anogeissus latifolia.*	
		43	1 5	*Buchanania latifolia.*	
		44	1 0	Sal (*Shorea robusta*).	

Year of dibbling.	Name of block.	No. of plants.	Height.		Associate Species.	REMARKS.
			Ft.	in.		
1915	Dechua	45	3	7	Sal (*Shorea robusta*).	
		46	2	0	*Lagerstrœmia parviflora.*	
		47	1	8	,, ,,	
		48	1	6	*Phyllanthus Emblica.*	
		49	1	0	,, ,,	
,,	Lohera	50	1	5	Sal (*Shorea robusta*).	
		51	1	5	,, ,, ,,	
		52	1	4	,, ,, ,,	
		53	1	2	,, ,, ,,	
,,	Chandlidungri ...	54	1	6	*Acacia Catechu.*	
		55	1	6	*Terminalia belerica.*	
		56	1	6	,, ,,	
		57	1	6	*Buchanania latifolia.*	
		58	1	6	*Cleistanthus collinus.*	
		59	1	6	*Anogeissus latifolia.*	
		60	1	6	,, ,,	
		61	1	5	*Buchanania latifolia.*	
		62	1	3	*Pterocarpus Marsupium.*	
,,	Kandrapat ...	63	1	6	*Anogeissus latifolia.*	
		64	1	5	*Lagerstrœmia parviflora.*	
		65	1	2	*Buchanania latifolia.*	
		66	1	2	*Zizyphus.*	
		67	1	2	*Terminalia belerica.*	
		68	1	0	*Zizyphus.*	
		69	1	0	,,	
		70	1	0	,,	

Year of dibbling.	Name of block.	No. of plants.	Height.	Associate Species.	REMARKS.
			Ft. in.		
1915	Dekulba ...	71	2 3	*Diospyros Melanoxylon.*	
		72	2 1	*Eugenia Jambolana.*	
		73	2 0	*Diospyros Melanoxylon.*	
		74	2 0	,, ,,	
		75	2 0	*Anogeissus latifolia.*	
		76	2 0	*Eugenia Jambolana.*	
		77	2 0	*Anogeissus latifolia.*	
		78	1 9	*Eugenia Jambolana.*	
,,	Forest Office compound	79	4 3	Nil.	
,,	Lachmidungri ...	80	1 5	*Cleistanthus collinus.*	
		81	1 6	*Odina Wodier.*	
,,	Lamal-junan ...	82	1 6	,, ,,	
		83	1 6	*Diospyros Melanoxylon.*	
,,	Jamra	84	1 10	Sal (*Shorea robusta*).	
		85	1 8	*Holarrhena antidysenterica.*	
,,	Bhowerkhol ...	86	5 6	Nil.	
		87	2 6	,,	
		88	1 2	*Diospyros Melanoxylon.*	
,,	Sunaridungri ...	89	2 0	Sal (*Shorea robusta*)	
		90	1 7	,,	
,,	Desir	91	1 3	*Buchanania latifolia.*	
,,	Budharaja ...	92	1 5	*Butea frondosa.*	
,,	Adapara ...	93	2 6	*Eugenia Jambolana.*	
		94	2 5	Sal (*Shorea robusta*).	
,,	Lambaidungri ..	95	2 4	*Bassia latifolia.*	
		96	2 0	Nil.	

Year of dibbling.	Name of block.	No. of plants.	Height.	Associate Species.	REMARKS.
			Ft. in.		
1915	Jhurghati ...	97	1 5	*Pterocarpus Marsupium.*	
,,	Sambalpur Town Hall compound.	98	2 0	Bamboo	
		99	2 9	*Casearia tomentosa.*	
,,	Lambdungri ...	100	1 9	*Buchanania latifolia.*	

The dibbling of 1916 and its results.

The dibbling operation was continued also during 1916 and, as in previous years, the seeds were dibbled over an approximate area of 200 acres, chiefly in the old plots. A large number of plots was inspected by me in September and October, and also in December 1916. The germination of the seed was good, and the plants are now very healthy. Mr. Pearson, Forest Economist, who came to Sambalpur in December 1916 to inspect the Bija experiments, was kind enough to inspect some of the Sandal areas close to Sambalpur and was pleased with the results.

In the beginning of June 1916, a number of Sandal plants of 1914-15, which were close together in the patches, were removed and transplanted to other places. About 75 per cent. of the plants thus transplanted have survived and are now healthy.

The results so far obtained, in the dibbling of Sandal seeds, appear to be satisfactory, and it will be better if this operation is continued in a more systematic manner. For this purpose, the areas intended for operation should be previously selected. A list of such areas should be prepared, and divided into convenient working circles. Each of these working circles should be divided, say, into fifteen or twenty compartments, one of which should be taken in hand each year, and the results should be carefully noted in a bound book to serve as a future record.

In future, the method of dibbling the seeds, as now practised in Coorg, will be followed, and the results will be carefully watched and published in the *Indian Forester.*

NOTE ON THE STRENGTH OF GLUE.

BY R. S. PEARSON, I.F.S.

The question not infrequently crops up as to what is a suitable Glue for general purposes in carpentry and, so as to obtain definite information on the subject, a few preliminary tests were carried out to ascertain the strength of adhesion of pieces of wood when glued together with various solutions.

To carry out such tests, a number of wood specimens were prepared, cut carefully to 6" × 1" × 1", out of a strong timber *(Pterocarpus dalbergioides)*, and pairs of these pieces of wood glued together at right angles to each other. The specimens so prepared were allowed to remain under a heavy weight for two or three days until the Glue had set. Each set of specimens was then subjected to an increasing tensile strain, until rupture occurred.

The following are the results obtained with different qualities of Glue, the figures being the average of two or more tests :—

Experiment number.	Composition of Glue.	No. of lbs. required to cause rupture, per sq. inch.
1 ...	Common Glue purchased in the bazaar mixed with an equal quantity of water	159
2 ...	Common Glue purchased in the bazaar mixed with two parts of water ...	172
3 ...	Croid Glue, Extra strong	153
4 ...	Croid Glue, Ordinary	168
5 ...	Croid, Extra strong mixed with equal quantity of water	137
6 ...	Croid, Ordinary mixed with equal quantity of water	45

From the above results, it will be seen that the Common Bazaar Glue, mixed with equal parts of water, shows less resistance to tensile strain than when used with twice as much water, and the same is the case with the Croid Glue, in which Extra Strong gave not quite so good results as the Ordinary.

To explain these results is not easy; the only suggestion that can be offered is that the two surfaces of the wood were brought into closer contact by using a more liquid Glue than was the case when using the stronger solution. It will be necessary to repeat these tests before a final opinion can be expressed as to the correct value of these solutions.

NOTE ON *URGINEA INDICA*, KUNTH.

BY H. H. HAINES, I.F.S.

In the *Indian Forester* for February 1917, there is a note on *Urginea indica*. As the botanical characters of this plant are given, and other details of its flowering, I would like to point out an interesting feature which has been omitted. In the Flora of British India, the perianth is described as *campanulate*, and this character is given in other works I have consulted including, I regret to say, my own Flora of Chota Nagpur as, at that time, I had not observed the plant late of an evening. The description of the flowers of Scilla is given as *stellate* or *campanulate*, and although that description was not intended to mean in one and the same species, it really does apply to some species of both Scilla and Urginea. If one walks along a fire-line on a moonlight night, all the flowers of *Urginea indica* whose night out it is—they only get one each in their lives—will be found wide open, stellately spreading and fragrant. It is then a very graceful pretty plant. Next morning all the flowers are campanulate, in which condition they have always been described.

KING-EMPEROR'S BIRTHDAY HONOURS' LIST, 1917.

We are glad to see that the title of **Rai Bahadur** has been conferred upon Mr. Shiam Sunder Lal, Extra-Assistant Conservator of Forests, *on deputation to Indore State*; and the title of **Kyet thaye Zaung Shwe Salwe ya Min**, as a personal distinction upon Mr. Maung Tha Myaing, A.T.M., Extra-Assistant Conservator of Forests, in Burma.

EXTRACTS.

MAHUA AND ACETONE.

Only in our last issue, in reviewing a copy of the January number of "The Calcutta Review," we said "truly the Mahua, among forest trees, stands equally for idealism and utilitariansim" and therefore it is with all the greater interest that we have perused a pamphlet on the Industrial Potentialities of Hyderabad, by Mr. G. E. C. Wakefield, Director-General of Revenue of that State, in which he refers to the existence in the Mahua flowers of acetic acid, and acetone we know is very important and more so now than ever, for acetone is one of the primary ingredients of cordite, the chief explosive used in the guns which are thundering on different battle fronts in Europe. Mr. Wakefield in his pamphlet points out that he learnt on a visit to the Cordite Factory, situated near Ooty on the Nilgiris, that acetone had to be imported all the way from Canada where it was manufactured out of wood. In order, it appears, to produce one ton of acetone it was necessary to cut down and boil a hundred tons of wood. Mr. Wakefield pointed out to the authorities the possibilities of Mahua in the direction of acetone production—the fresh Mahua flowers produce, weight for weight, nearly ten times as much acetone as can be got from wood and no destruction of useful material is involved. So the chemists were set working, experiments were made and acetone has been satisfactorily produced. The process of gaining a hearing from the India Office was slow, but eventually Dr. Fowler, an eminent chemist, was sent out to India and he is going to manufacture acetone from Mahua on a large scale at Nasik, Bombay Presidency. Government, we learn, from the "Advocate of India," are to spend some seven lakhs of rupees in erecting a special factory there and have already purchased from Hyderabad about Rs. 70,000 worth of Mahua flowers.—[*Indian Engineering.*]

VOLUME XLIII NUMBER 8

INDIAN FORESTER

AUGUST, 1917.

TEAK REGENERATION UNDER THE UNIFORM SYSTEM IN MOHNYIN.

BY H. R. BLANFORD, I.F.S.

INTRODUCTION.

The Mohnyin working circle is situated in Katha Division, Upper Burma. It had been worked under the Selection system under a working-plan since 1895.

The revised working-plan, based on the Uniform system, was introduced in 1910. Regeneration has now been carried out for five years under this plan and the results and lessons learnt are of some interest. In view of the recent correspondence in the *Indian Forester*, it would appear necessary to add the warning that I am not advocating the general adoption of the system as carried out in Mohnyin. That the regeneration work carried out is of general interest must be my excuse for this note.

DESCRIPTION OF WORKING CIRCLE.

(i) *General.*

The working circle is composed of the Mohnyin and Bilumyo reserves (37·7 and 5·2 square miles respectively). The reserves,

which mostly lie at an altitude of between 700 feet and 1,200 feet above mean sea-level, are situated partly on the low watershed between the Ledan and Nanyin streams, and partly along the foot of the hills in the left drainage of the Nanyin stream. The country is fairly level, and the soil a deep loam in all localities where the better class of forest is found. The rainfall is about 70 inches per annum.

(ii) *Forest.*

By no means the whole of the working circle is composed of teak forest. Moist teak forest suitable for the method proposed is estimated at 23 per cent. of the total area, but a considerable portion of the 21 per cent. covered by evergreen will probably be found to be suitable for conversion into teak forest. In addition to this, 4 per cent. is composed of dry teak forest too poor in quality to be worked under the method proposed, 34 per cent. of dry deciduous forest or "Indaing" and 7 per cent. of grass swamps.

The teak forest is of a type by no means common in Burma. It is best described as "Plains teak forest." Its chief characteristics are the absence of bamboos and the large proportion of teak contained in the growing stock. In many places the forest may be termed pure teak forest. Characteristic associates are Thadi (*Protium serratum*), Yemane (*Gmelina arborea*) and Yon (*Anogeissus* sp.). The undergrowth is composed largely of evergreen shrubs and, where the cover is open, of grass. Bamboos are only found occasionally, usually near streams, the commonest species being *Dendrocalamus Hamiltonii*. Probably owing to the large proportion of teak in the growing stock and also, it is believed, to the insufficient drainage in the lower lying portions and to the general dampness of the atmosphere, this forest is noted for its fine examples of "beeholed" timber, a serious detriment to the value of the outturn. Experience, however, leads to the conclusion that although "beeholes" occur throughout the forest, areas where the worst attacks are found are local. Apart from "beeholes," the timber varies very much in quality. In many parts of the forest

the trees attain a fine length of bole but, in others, notably the more open forests, especially where grass has got in, many trees are forked and very badly shaped.

METHOD OF TREATMENT ADOPTED.

Experiments had been carried out by the late J. Messer and by W. T. T. McHarg to ascertain the best method of regenerating the teak forest, in which, as a rule, regeneration was conspicuously lacking. These have proved that regeneration can be obtained in profusion by girdling the teak and felling, cutting and burning all other cover and the undergrowth. Expensive weeding for 2 or 3 years after regeneration is, however, necessary. This system of regeneration has been adopted but has, of course, been somewhat modified by subsequent experience.

The rotation has been fixed at 180 years, at which age ring countings showed the average tree would attain a girth of 8 feet. The area has been divided into nine blocks containing a more or less equal stock of teak, combined with an equal area of teak forest suitable for the method proposed. One of these blocks, No. 1, is designated the Regeneration block, to be worked over during the first period of 20 years for which the plan has been drawn up. On this area all trees down to 6 feet are to be girdled for regeneration, and the block has further been divided into four 5-year coupes to be known as compartments.

Burning of the regeneration area is prescribed for two years before regeneration, with a view to obtaining advance growth, and cutting and burning, followed by regeneration, is prescribed for the same season as girdling. The regeneration of each compartment is arranged to be carried out in the first year of the 5-year sub-periods if possible, but it is left to the D. F. O. to carry out a portion only in the first year, and complete regeneration over the rest of the compartment in the second year, if he considers it necessary. Weeding of the regeneration is prescribed for two or three years until the seedlings are established, to be followed by cleaning and cutting back of damaged shoots, after extraction of girdled trees. It is especially stipulated that a pure crop of teak

is not the object in view, but that a crop containing about 50 per cent. teak is to be established, the remainder, if possible, to consist of timber-producing species. All regeneration areas are, of course, to be fire-protected. Over the other blocks, girdlings of over-mature trees are prescribed under the Selection method, combined with improvement fellings after completion of extraction of girdled trees. Fire-protection is to be continued but each block is to be burnt for two years before, and for six years after, girdling to endeavour to induce regeneration. In the event of regeneration having been satisfactorily obtained, fire-protection will then be re-introduced.

The plan has not been running long enough to give the general method of working a fair trial, and I do not propose to do more here than deal with the regeneration work carried out up to date, as on the success or failure of this depends the entire method; other prescriptions are of minor interest.

A.—Regeneration works carried out in Compartment 1 *of the Regeneration Block*, 1910 *to* 1915.

Compartment 1 is situated in the northernmost corner of the Bilumyo reserve, in which no girdlings had ever previously been carried out. The area consists chiefly of level low-lying ground, rising slightly to the south, where teak forest gives way to "Indaing." In the west, however, there is teak forest on higher ground, composed of spurs with moderately steep slopes and the ground is more broken. The forest contained almost pure teak but, in the west on the higher ground, Wabo (*D. Hamiltonii*) was present and there were a few trees of other species. The rest of the compartment in the south consists of Ingyin forest, with a narrow strip along the south-west of evergreen with few teak, which was not at first considered suitable for regeneration.

Before proceeding further, it should be noted that the prescription of burning two years before regeneration proved to be wrong, as it resulted in the premature appearance of a considerable number of seedlings which died back, owing to want of light and weeding. Teak seed stays good for many years in the soil and

does not usually germinate until the area is burnt. The result of this preliminary burning was, therefore, to reduce the accumulated stock of seed in the ground without any corresponding result.

Originally, it was only intended to regenerate about half the area suitable in the first year 1910-1911 ; but the area was inspected by the officiating Chief Conservator and Conservator at the end of 1910 and they ordered that while the method of regeneration with weeding, as prescribed, was to be carried out over half the area, the other half was to be regenerated but no weeding was to be done. Instead, the area was to be burnt annually in the hope that gradually the teak seedlings would establish themselves with the help of fire. This was carried out and it is, therefore, necessary to deal with these two areas separately. The total area undertaken was 163 acres. All teak down to 6 feet and badly shaped or solitary trees below this girth, were girdled during the season 1910-1911. In all 2,183 trees were girdled. In girdling, compact groups of teak under 6 feet girth were left, but otherwise most of the teak on the area were girdled. After girdling, all trees other than teak were girdled or felled and the whole area burnt. Burning was unfortunately not very effective. In regeneration work, as in clearing for temporary cultivation, it is always found necessary to cut up, pile in heaps, and burn again all unburnt material. Owing to the ineffective burning, this work was very heavy and could only be completed over the area on which weedings were to be carried out. The total cost of clearing and burning amounted to Rs. 1,127, of which, Rs. 785 was expended on the area to be weeded or just over Rs. 10 per acre.

I. *Area in which weeding was carried out from the start.*

(*a*) *Natural Regeneration.*—At the commencement of the rains of 1911 teak seedlings sprang up in great numbers over most of the area. These were weeded from the first and, by the end of the rains, were showing up well, chiefly in compact groups. One noticeable point was the failure of seedlings to thrive under the crowns of ungirdled teak. This was not due so much to the shade as to the drip of rain-water from the leaves splashing mud on the seedlings, many of which were caked with mud and died. Owing to this, it

was found necessary to girdle considerably more of the remaining teak. Another point was that very little else was found coming up with the teak, and it was found impossible to obtain the desired mixture of other species. The area was weeded in 1912 and the leading trees had attained a height of 12 feet. In this year, however, grass commenced to make its appearance and has by now become established in the area, except where the young teak formed compact groups. Since 1912, beyond occasional cutting of creepers and grass and coppicing of damaged trees after extraction, little work has been necessary. Plate 16 shows good pieces of this area taken at the end of the rains of 1915. It will be noticed that a considerable area in the fore-ground is devoid of teak or nearly so, and grass has got a firm hold. As a matter of fact, the few teak there were had recently been cut back after being damaged in extraction, which had just been completed when the photo was taken. Two sample plots in this area, one acre each, have been counted annually with the following results:—

		No. 1.	No. 2.
May 1911	...	1,071 seedlings	582 seedlings.
October 1911	...	850 „	445 „
June 1912	...	738 „	360 „
„ 1913	...	654 „	322 „
„ 1914	...	583 „	323 „
August 1915	...	409 „ after extraction.	not counted as extraction proceeding.
June 1916	...	359 trees	242 trees.

Unfortunately, neither of these plots were counted in patches of really good regeneration and, in both, grass has got in to the detriment of the teak, thus accounting for the steady decrease in numbers. This year, 1916, it has further been found that the teak in this area, where grass has got in, have put on very little height-growth and that the leaves are turning yellow. This somewhat serious state of affairs has previously been noticed in plantations where grass has taken possession of the ground. It is thought

Photo.-Mechl. Dept., Thomason College, Roorkee.

1911. Natural Regeneration weeded from the first. (Photo taken November 1915.)

that the dense growth of grass prevents any passage of air to the soil and that the roots of the grass further prevent soil-aeration, also causing water to stagnate in the soil. The result of this may be a sour soil in which teak cannot thrive. Remedies appear difficult except at a great cost. It may be noted that grass is a well-known enemy in fruit orchards and rubber plantations. Cutting back the grass and working the soil would, I believe, right the matter. Draining might also have a beneficial effect. A more drastic remedy would be to burn the area. Even then the damaged teak, and with the growth of grass on the ground most of the teak would be damaged, would have to be cut back with the possible result that when the coppice shoots re-attained the present height of the trees, the same state of soil would again result. It is worthy of note, however, that coppice shoots cut back after extraction do not show any signs of retarded growth and many have shot up to 8 to 10 feet in height in the rains of 1916.

Regeneration was not, however, obtained in the first year throughout the area. For some reason, never yet discovered, a portion of the area was almost devoid of seedlings. Efforts were made in 1912, by clearing small patches, to induce germination of teak seed but without success, and in the hot weather of 1913 the area was burnt. The result was abundant regeneration, although practically all the seed-bearers had been girdled in 1911. This goes to show that teak seed remains good in the ground for two years at least, and that it is not necessary to regenerate immediately after girdling the seed-bearers. It might, therefore, be feasible to leave regeneration until after the extraction of the girdled teak. I shall have occasion to refer to this question again. The regeneration of 1913 is remarkable for its comparatively slow growth, as compared with the growth in the first two years after regeneration. Weeding had to be more constantly repeated and this was further necessitated by the fact that by the time regeneration was obtained, grass and weeds had got a thorough hold on the ground. The expense was, therefore, greater and it is doubtful if this portion of the area will ever be really successful.

(*b*) *Artificial Regeneration.*—An area of about 17 acres in the middle of the weeded portion contained no teak in the original growing stock, which consisted of evergreen species. This area was cleared and burnt with the rest and, during the rains of 1911, was planted up partly 6′ × 6′ and partly 30′ × 30′. The object of the latter spacing was to endeavour to obtain a mixture of other species between the teak. It has, of course, resulted in a very strong growth of grass although it must be admitted that there are a number of other species also springing up in the area. The teak do not appear to have been affected in the same way as those in the natural regeneration area mentioned above, where grass has got a firm hold, but the locality is slightly different and whereas the grass here is almost entirely Kaing (*Saccharum* sp.), that in the part where the teak show a falling off in height-growth, is largely Thekke (*Imperatum* sp.).

The plot planted 6′×6′ has been most successful. It has shown extraordinary growth from the start and has hardly required weeding after the first year. Plate 17 shows it at the end of the rains of 1911 when five months old. The trees rapidly grew together and formed a dense canopy under which grass is entirely absent. Plate 18 gives some idea of this plot taken at the end of the rains of 1915 after five seasons' growth. It is noticeable that in this plot, where there is no grass and where the ground is fairly clear, the trees show no falling off in growth. The trees now, after only six seasons' growth, are badly in need of a thinning.

II. *Area in which weeding was not done during the rains of* 1911.

This must be dealt with under two or three different heads. After the rains of 1911, it was found that it was quite impossible to do without weeding and all but a very small area has since been weeded. The small area which has not been weeded at all was merely left as the "awful warning." It is an absolute and complete failure. With the exception of one or two coppice shoots, there is no teak on it at all—the growth consisting largely of grass. It has been burnt most years without result. In the part weeded from 1912 onwards, the area falls naturally into two

Photo.-Mechl. Dept., Thomason College, Roorkee.

Area planted 6′ × 6′ in 1911. (Photo taken November 1911.)

classes, *i.e.*, the lower level ground to the east, and the more broken ground and spurs in the west. These differ principally owing to the different kinds of growth that sprang up. In both areas, the regeneration springing up early in the rains of 1911 was even more abundant than in the weeded area.

(*a*) *On the lower ground.*—The growth was chiefly herbaceous weeds, which sprang up very rapidly indeed and soon smothered the teak. Plate 19 gives a good idea of this. It will be seen that the weeds are largely of one kind. This is a species of ginger known in Burmese as "Hmalanyutkwin." It is not to be wondered at that few teak seedlings could exist for long under the dense cover of this growth and, at the end of the first rains, very few survived, though a few minute seedlings could still be found after a very careful search. The area was cleared again in the hot weather of 1912 and attempts made to burn without much success, as all the overhead teak having been girdled there was but little inflammable material on the ground. Moreover, the season was damp and unfavourable to burning. It may be noted here that the original idea of burning annually, with a view to avoiding expensive weeding, would be impossible to accomplish even if the seedlings survived as, at any rate, for one or two seasons, until the growth got up a bit, there would be practically nothing to burn. In damp forest such as this, burning is often difficult and is quite impossible in the absence of dead leaves or grass. In 1912, and even 1913, grass had not got in sufficiently to give a good fire. After the failure to burn, surviving seedlings were carefully searched for and weeded, and plots, where few or no seedlings could be found, had small patches, about ten yards in diameter, cleared, at intervals, to induce further regeneration. This was moderately successful. There are a certain number of teak now on this area but, as mentioned before, the height-growth is not to be compared with those which sprang up in the first year of regeneration, and constant weeding and cleaning is even now necessary, causing an expenditure out of all proportion to the results. A photo (Plate 20), taken at the end of the rains of 1915, gives a general idea of this area. As will be seen, teak

are only to be found here and there at intervals, many of them still showing groups of three or four trees, resulting from the patches cleared bare in 1912.

Two sample acre plots taken in this area, counted annually, gave the following results :—

		No. 3.		No. 4.
May 1911	...	2,589 seedlings	...	1,880 seedlings.
October 1911	...	232 ,,	...	Could not be counted.
June 1912	...	243 ,,	...	338 seedlings.
,, 1913	...	208 ,,	...	287 ,,
,, 1914	...	231 ,,	...	186 ,,
August 1915	...	149 ,,	...	156 ,,
(After extraction of girdled trees early in 1915.)				
June 1916	...	128 seedlings	...	104 seedlings.

Not only do these plots illustrate the sudden decrease owing to no weeding being done in 1911, but also to the constant yearly mortality of the few remaining seedlings owing to the grass. The grass in this area is partly Kaing (*Saccharum*) but is more largely Pyaungsa (*Pollinia eucnemis*).

(*b*) *On the higher ground* circumstances were somewhat more favourable. Instead of herbaceous weeds, a growth of woody species sprang up. These did not develop at first any more rapidly than the teak seedlings, which were thus enabled to establish their roots and many did quite well for two or three months. Then other species rapidly got ahead of the teak and, at the end of the first rains, the teak were mostly suppressed, and many of the seedlings had grown very weedy, in the vain effort to compete with the other faster growing species. This area has been weeded ever since and may now be considered to be satisfactorily regenerated. Weedings and cleanings are, however, still somewhat necessary in places, and the cost of the whole operation has been largely increased because no weeding was done in the first year.

A photo (Plate 21), taken at the end of the rains of 1915, shows a general view of one of the spurs in this area. It will be noticed that the teak is growing under a cover of Tama (*Melia*). These latter sprang up as seedlings in 1911 and have shown most extraordinary growth. They were at first left in the hope that,

in the absence of any other species, they would afford a mixture with the teak. Tama is believed to be absolutely worthless and it is probably not long-lived, so that it is likely, when it grows larger, to fall a victim to wind. These soft woods would undoubtedly cause great damage to the teak in the future, though at present their thin crowns are negligible, and in future this species will not be encouraged. Two sample plots of 1 acre each, taken in this area, gave the following results :—

		No. 5.		No. 6.
June 1911	...	2,698 seedlings	...	2,200 seedlings.
,, 1912	...	1,357 ,,	...	680 ,,
,, 1913	...	1,620 ,,	...	719 ,,
,, 1914	...	797 ,,*	...	711 ,,
(* After cutting back shoots damaged by extraction early in 1914.)				
August 1915	...	1079 seedlings	...	469 seedlings (at e extraction early in 1915).
June 1916	...	914 ,,	...	459 seedlings.

These figures show considerable improvement even on those in the area weeded the first year, but the big drop from 1911 to 1912 clearly shows the results of no weeding being done. The increase in both cases in June 1913 is due to small suppressed seedlings having escaped notice in 1912.

The decrease due to extraction is very marked, though in both plots there were plenty of undamaged trees to take the place of damaged ones.

Extraction in compartment 1.—It is necessary to say a few words about this. It was foreseen that considerable damage was unavoidable and such proved to be the case. In the working-plan, one year was prescribed for extraction, but the lessees found it impossible to complete it in that time. Extraction was commenced in April 1914 and even at the close of 1916 was not entirely completed, though the timber had all been dragged out of the actual area under regeneration. A scheme for extraction was drawn up so that felling and extraction were done successively in small coupes. This allowed for coppicing of damaged stems as soon as possible after felling, and reduced the actual period for extraction in each coupe to a comparatively short one. As long

as this scheme was kept to, it proved satisfactory. Unfortunately after three or four coupes had been completed it was disregarded, with the result that a considerable period elapsed between the time felling was done and the time extraction was finally completed. It was, of course, quite useless cutting back damaged shoots until there was no further risk of damage. Although the damage done was undoubtedly serious and, while extraction was in progress, looked almost irreparable, owing to the extraordinary facility with which teak stools send up new shoots, the crop has sprung up again fairly well. The most serious feature seems to be that the temporary gaps formed have considerably favoured the grass, which seems to have increased at the expense of the teak, where-ever it was previously firmly established. One point that should be noted in extraction is that it is best to coppice teak only during the period little or no growth is being put on, *i.e.*, January to early May, otherwise, weak shoots are sent up towards the end of the growing season, which do not, as a rule, thrive or produce nearly as healthy saplings as the shoots resulting from stools cut during the period of rest. Extraction should, therefore, be completed in each area before 1st April at the latest, to allow of damaged shoots being cut back before the rains.

Cost of the operation.—It is very much to be regretted that the details of cost were not kept separately for each method of treatment. Cost is an inseparable factor in the success or failure of any regeneration work, and I must plead inexperience as the only excuse for not having kept accurate details. It is only possible to give the cost, as a whole, up to the end of October 1916.

	Rs.
Clearing and burning	1,681
Weeding and cleaning	4,533
Coppicing	147
	6,361

The area is 163 acres, so this works out about Rs. 39 per acre. This is very high, but it should be remembered that the cost has been increased enormously by the failure to weed over more than

Photo.-Mechl. Dept., Thomason College, Roorkee.

Area planted 6′ × 6′ in 1911. The foreground planted 6′ × 6′ in 1916. Note *Melia* growing over teak, although of same age. These are now being cut out.

half the area in 1911. Moreover, inexperience led to the employment of more than sufficient coolies during the rains of 1911 and to letting out the clearing of the area by contract at a rate that is now known to be too high. Experience has proved that all the work can be done very much cheaper as will be shown hereafter.

CONCLUSIONS ARRIVED AT FROM REGENERATION OF 1911.

Before proceeding further, I will summarise the lessons learnt from the regeneration of compartment 1 up to the end of the first sub-period and the lines on which further work should be carried out.

1. It is absolutely impossible to avoid heavy and repeated weeding.

2. Very thorough and repeated weedings in the rains following regeneration are economical in the end.

3. If regeneration is not obtained abundantly in the first year, it is far better immediately to fill up artificially by transplants, than to wait for regeneration in the following years, when weeds and grass will have got a firm hold on the ground.

4. It is extremely difficult to obtain naturally the required mixture of other species and steps should be taken to introduce them artificially.

5. On the low-lying ground, especially if the growth is not thick enough to afford a continuous canopy very early, grass establishes itself with serious results, and must be kept out at all costs.

6. In order to regulate extraction of girdled trees small areas, which can easily be worked out between August of one year and March of the next, should be regenerated yearly, instead of regenerating the whole 5-year coupe in the first year or two years of the sub-period. This will, moreover, enable a regular number of elephants and buffaloes to be maintained specially for extraction of timber from regenerated areas, as the period during which extraction is not actually being carried out in the coupe can be utilized for the extraction of the timber from the edge of the coupe to the floating stream.

7. Even though the teak seed-bearers have been girdled two or three years, it is still possible to get regeneration by burning, owing to the power of teak seed to retain its germinating power for a number of years after falling. It might, therefore, be possible to defer regeneration, *i.e.*, felling and burning, until after the extraction of girdled trees.

8. That it is not advisable to leave any teak standing ungirdled except advance growth of small trees, in compact groups, where regeneration is not necessary.

The problems still remaining to be solved are—

(1) To evolve a cheaper method of regeneration.

(2) To ascertain the best species for mixing with the teak and the best method of producing the mixture.

(3) To ascertain whether regeneration can be obtained equally well by waiting until after the extraction of the girdled teak.

B.—Natural regeneration after extraction of girdlings.

I will now proceed to detail the work that has been carried out since the regeneration of compartment 1, showing what steps have been taken to deal with these questions. In 1915 it was decided, at the suggestion of the Inspector-General of Forests, who visited the area early in 1914, to attempt to regenerate the small semi-evergreen area, on the edge of the drier forest in the south-west of compartment 1, after extraction of the girdlings. The area contained a certain proportion of teak sufficient for the experiment, but the forest growth was not by any means typical of the forest elsewhere in the reserve. There were, moreover, a fair number of smaller ungirdled teak on the ground which might have been responsible for the regeneration which subsequently appeared. After extraction of girdled teak, the area was cut and burnt in the usual way. Regeneration was only moderate.

Sample plots of one acre each gave the following countings :—

	June 1915. No. of seedlings.		June 1916. No. of seedlings.
No. 1 ...	217	...	320
No. 2 ...	283	...	286
No. 3 ...	168	...	159

The teak regeneration, although poor in numbers, consists of good healthy plants and in the number of seedlings of useful species found growing up with the teak this area shows promise. The original forest was, however, hardly typical and the large number of species springing up cannot be expected in other areas regenerated in this reserve, where teak is usually the predominant species.

C.—Artificial regeneration after extraction of girdlings.

Only a portion of the area taken in hand in 1915 was regenerated naturally. Over an area of about 6 acres, natural seedlings, assisted where necessary by nursery plants, were transplanted into lines alternating with lines of other species, the lines being 9 feet apart with the plants 6 feet apart in the lines. The following species were planted with the teak in separate plots of about one acre each: - Ngu (*Cassia Fistula*), Pyingado (*Xylia dolabriformis*), Aukchinsa (*Dysoxylum binectariferum*), Eikmwè (*Lagerstrœmia Flos-Reginæ*), Yemane (*Gmelina arborea*), Taungletpan (*Bombax insigne*) and Taungdama (*Cedrela Toona*). The object of these plots is to discover a suitable species for planting with teak. It is as yet too early to say which is likely to be suitable but Yamane would appear to be too rapid growing and branchy to mix with teak, unless in strips of several lines alternating with several lines of teak. Taungdama and Eikmwè are both doing well, and the latter especially is likely to be suitable, as it is not so rapid in growth as the teak, and is likely to stand the shade of the teak to a certain extent.

D.—Arrangements for regeneration in second sub-period 1915 *to* 1920.

With the year 1915-16 a new sub-period was started in which compartment 2 was prescribed for regeneration. Compartment 2 is not nearly so compact as compartment 1, and contains several isolated patches of teak forest suitable for regeneration, together with a large area of swamp and drier Indaing forest. It has been decided to divide the area suitable for regeneration into five coupes A to E, and to regenerate only one coupe annually. It may here be mentioned that the object of reducing the area to

be regenerated in any one year was not because it was found impossible to carry out the works of regeneration over so large an area, but simply and solely because difficulties were found in getting the extraction completed expeditiously. It is unfortunate that, in this area, we are entirely dependant on the lessees to get the extraction completed. There would be no great difficulty in regenerating each year a considerably larger area than is necessary under the working-plan.

In order to arrange for the regeneration after extraction in one coupe to see if this can be done, the working of the five coupes has been arranged as follows :—

1915-16 ...	Girdle and regenerate Coupe A.
1916-17 ...	Girdle Coupe B. Girdle and regenerate Coupe C.
1917-18 ...	Girdle and regenerate Coupe D.
1918-19 ...	Extraction Coupe A. Girdle and regenerate Coupe E.
1919-20 ...	Extraction Coupe B followed by regeneration. Extraction Coupe C.

The trees girdled in Coupe B after standing three years will be extracted between October 1919 and March 1920 and the regeneration of this coupe will, if possible, take place in the rains of 1920.

E.—Works carried out in 1915-16.

In addition to regenerating Coupe A in 1915-16, it was resolved to experiment with the *taungya* method (temporary cultivation) with natural and artificial regeneration, on some small areas (extensions) which had not previously been included in the reserve but which contained teak forest excellently suited for natural regeneration. These areas are now being reserved.

The following works were, therefore, taken in hand during 1915-16:—

(1) *Compartment* 2, *Coupe A*—

(*a*) 22 acres. Regenerated under the working-plan method.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Area regenerated 1911 but not weeded, showing dense growth of "Hmã-la-nyut-kwin." (Photo taken July 1911.)

(*b*) 11 acres. Natural seedlings transplanted 6′ apart in lines 9′ apart; part pure teak and part mixed with Taungdama (*Cedrela*).

(2) *Extensions* 1 *and* 2—

21 acres. Natural seedlings transplanted into lines, 6′ × 6′, on low-lying ground where there is danger of a rapid growth of grass.

(3) *Extension No.* 3—

(*a*) 22 acres. Natural regeneration combined with *taungya*

(*b*) 21 acres. Natural seedlings transplanted into lines in *taungya*.

(4) *In extension No.* 5—

7 acres. Nursery seedlings transplanted in a newly cut *taungya* with paddy.

(5) *In extension No.* 5—

18 acres. Nursery seedlings planted in a *taungya* cut in 1914 from which two crops of paddy have already been taken in 1914 and 1915 and which has now been left fallow.

I write at the close of 1916 and can only review the results of the work of the first rains in these areas. The work, as a whole, has been so successful and has such an important bearing on the future method that I will deal with each area separately.

(1) *Compartment* 2, *Coupe A*.—This area consisted of almost pure teak gradually merging into evergreen in the west. It is a long narrow strip on both sides of a small nullah. The slopes are gentle to moderately steep. With few exceptions the teak were all girdled over during the cold weather of 1915-16, and the whole of rest of the jungle felled and burnt during the hot weather of 1916. The rains of 1916 were very late, and there was very little rain until towards the end of July, which seriously retarded germination. Although a considerable number of seedlings germinated in June germination was still continuing in July. The part of the area east of the nullah has simply been weeded. The results are excellent An acre sample plot in this area which gave 1,656 teak seedlings

in June was counted very carefully in October 1916 and gave the following results :—

Teak	...	2,775	seedlings.
Zinbyun (*Dillenia pulcherrima*)		201	"
Thadi (*Protium serratum*)	...	253	" and root-suckers.
Tauksha (*Vitex* spp.)	...	87	"
Tama (*Melia*) ...	...	80	"
Tapesa (*Garuga pinnata*)	...	55	"
Taungdama (*Cedrela* sp.)	...	21	"
Petwun (*Macaranga*)	...	8	"
Yemane (*Gmelina arborea*)	...	5	"
Thitsein (*Terminalia belerica*)	...	11	"
Shaw (*Sterculia* sp.)	...	24	"
Ngu (*Cassia Fistula*)	...	3	"
Letpan (*Bombax insigne*)	...	13	"
Gwe (*Spondias*) ...	...	5	"
Thanat (*Albizzia*) ...	...	6	"
Thabutthein (*Miliusa*)	...	10	"
Nabè (*Odina Wodier*)	...	6	"
Mezali (*Cassia*) ...	...	3	"
Total	...	3,566	

Although the teak preponderates there are sufficient other species to give the required mixture, if care is taken to favour them at the expense of teak.

The area west of the nullah also showed good natural regeneration. On this area, the natural seedlings have been planted 6′ apart, in lines 9′ apart, while over about half the area lines of Taungdama (*Cedrela*) have been planted alternately with lines of teak. This area shows up well. Most of the transplants survive and show fair growth, though somewhat retarded by late planting due to the failure of the early rains.

The cost of the work compares very favourably with the cost of similar work in compartment 1.

Photo.-Mecnl. Dept., Thomason College, Roorkee.

Area regenerated 1911, but not weeded in 1911. Low-lying. Weeded from 1912 on. Shows few scattered teak and dense growth of grass. (Photo taken November 1915.)

(*a*) *Natural regeneration*—

Clearing	Cost	Rs.	166,	per acre		Rs.	7·6.
Weeding	"	"	128	"	"	"	5·8.
Total	"	"	294	"	"	"	13·4.

(*b*) *Planted area*—

Clearing Cost	Rs.	83,	per acre		Rs.	7·6.
Planting and Weeding	"	108	"	"	"	9·8.
Total	"	191	"	"	"	17·4.

The idea of transplanting natural seedlings is twofold. Firstly, it is thought that the reduction in cost of weeding will more than compensate for the extra expense of transplanting, as weeding is done so much more expeditiously in lines. Secondly transplanting facilitates the introduction of other species and, even where these are not introduced, gives more chance for other species to spring up between the lines where no weeding is done, as coolies often cut back valuable species when weeding the teak in naturally regenerated areas.

(2) *Extensions* 1 *and* 2.—This area consisted of open teak forest with grass. It is essential in such areas to get a close canopy as early as possible in order to kill out the grass and the areas have been planted up 6′ × 6′ over the greater part. Natural regeneration was only moderate and nursery transplants had to be used largely. An area of rather over an acre has been planted with Yemane (*Gmelina*) 6′ × 6′ and has succeeded very well. Even in the first season the plants have grown together and are 4′ to 5′ high. It remains to be seen if the cover of this species is sufficiently heavy to kill off the grass, but if it does, Yemane should prove an excellent species to fill up blanks. Its extremely rapid growth reduces the cost of weeding and promises early returns. A good deal more planting of Yemane might be done, as it is a most useful timber and even now fetches a good price.

The cost in this area has been heavier than in others, as constant weeding of the grass was necessary although the original clearing did not cost very much.

Cost per acre clearing	...	...	Rs.	4·3
Planting and weeding	...	...	"	11·4
Total		...	"	15·7

(3) *Extension No.* 3, *Taungya.*—The results of this operation are most important and would seem to indicate that this should be the method to be adopted generally in regeneration in the working circle. Considerable difficulty was experienced with the Kachins who cut the *taungyas* but that is inevitable at the start. There should be no difficulty, now that it is known that this method is so successful, in making proper arrangements by establishing forest villages in the reserve to cut *taungyas* annually where required.

Arrangements were made with a Kachin village situated close to the reserve to cut *taungyas* and plant paddy over the area in Extension 3 in return for permission to work paddy-fields in a suitable area in the reserve. All the teak were girdled on the area. After cutting over the whole area, the Kachins said that the spirits were not propitious, and it was with great difficulty that three men were persuaded to continue work over about half the area. This portion was burnt and cleared by the Kachins. This cost nothing. Natural regeneration was abundant except in small patches where there were no seed-bearers. These were planted up departmentally with transplants from the natural regeneration, at the same time as the paddy was sown by the Kachins. No other teak were introduced artificially, and the greater part of the area is under natural regeneration. The teak seedlings have been weeded by the Kachins when they weeded the paddy, which has to be weeded very much more thoroughly than is possible in the case of natural regeneration of teak, except at a prohibitive cost. The results are extraordinary. The teak has shown astonishing growth and few seedlings appear to have died. Much of the teak is as high as the

Photo.-Mechl. Dept., Thomason College, Roorkee.

Area regenerated 1911, but not weeded in 1911. Higher ground in west. Weeded from 1912 on. Note strong overgrowth of *Melia*. (Photo taken November 1915.)

paddy, which is of good growth, 4 or even 5 feet in height. A sample acre taken in this area gave the following results :—

June 1916	... ...	2,965 teak seedlings.
November 1916 (after the paddy had been reaped) ...	...	3,262 teak seedlings and 281 seedlings of other species.

In the area on which the Kachins refused to work, the cutting up of unburnt refuse had to be done departmentally and the area was then planted up in lines 9 feet apart with seedlings 6 feet apart in lines. Twenty feet clear was left unplanted between every lot of four lines, to help in getting up other species. The wives and womenfolk of the subordinates and coolies engaged on regeneration work were then allowed to sow paddy and vegetables on condition that they weeded the teak free. The weeding has, therefore, cost nothing. This has also been very successful. Although the planting was rather late, owing to the unfavourable season, the plants are healthy and many show good growth. A sample acre on which natural regeneration had been counted before planting was not interfered with and gave the following results :—

June 1916	... ...	1,596 teak seedlings.
November 1916 (after the paddy had been reaped) ...	...	1,444 teak seedlings and 214 seedlings of other species.

In both areas there are a fair number of seedlings of other useful species, of which the following are especially noticeable :—

Yemane, Thadi and Taungposa (*Morus laevigata*). Others will doubtless show up when the paddy has been reaped. The cost of work in this area is very interesting.

In the Kachin *taungya*, 22 acres, the total cost is Rs. 43 or Rs. 2 per acre. Considerably more than half this cost has been caused by the necessity of weeding small patches on which the Kachins did not see fit to plant paddy.

In the area on which paddy was sown by the women, 21 acres, the total cost was Rs. 120 or Rs. 5·7 per acre.

The latter, however, includes the additional cost of clearing after burning, which would not have been incurred had the Kachins carried out their agreement. Judging from the state of the crop future expenditure should be very small. The teak are not threatened by weeds, and all weeds have been pulled out by Kachins when weeding their paddy and should never be very abundant. Probably a further expenditure of Rs. 5 per acre at the outside should see this area successfully regenerated.

(Plate 22) shows a small patch on which paddy has been reaped showing natural regeneration. (On the right the background unreaped paddy.)

(4) *Extension No.* 5. *Planting in a newly cut taungya in evergreen forest.*—The area was cleared by Kachins in the ordinary way for *taungya*, and nursery transplants were put in 6′ × 9′ at the same time as the Kachins sowed their paddy. The planting was, however, very late and planting had to be done twice owing to the first planting having failed. As far as can be seen at present, the area has not been very successful though a fair proportion (about 60 per cent.) of the teak has survived. The weeding has been done by the Kachins and the only expenditure has been the planting, cost Rs. 7 per acre. The subordinate in charge was rather slack and this area suffered by being subsidiary to other more important regeneration works already described. It is, however, too early to say what the final results will be.

(5) *Extension No.* 5. *Planting in a taungya cut in* 1914 *from which crops of paddy had been taken in* 1914 *and* 1915, *and which had been left fallow in* 1916.—Owing to the thorough weeding which had been made by the Kachins for two years, weeds are not bad on this area. It has been planted up 9′ × 6′ with 27′ left clear between each set of five lines. Plants are small but a fair number have survived and a considerable proportion of teak has been ensured at a low cost on an area that would otherwise lapse to worthless jungle. In this connection, it may be pointed out that in *taungyas* cut in forest where there are teak seed-bearers there is always fairly good natural regeneration of teak which is, however, weeded out by the Kachins. It is only necessary to

Photo.-Mechl. Dept., Thomason College, Roorkee.

1916. Taungya with natural regeneration. Paddy reaped in foreground : not yet reaped in background to the right. (Photo taken November 1916.)

compel the Kachins to respect teak seedlings, to get quite a number of teak in the resulting growth after the *taungya* is allowed to fallow. The area has been weeded departmentally.

Cost in this area works out at Rs. 8·8 per acre.

SUMMARY.

Results of recent work go to show the great advantages to be derived from combining regeneration with *taungya* cutting. Not only is the success as good as, if not better than, the natural regeneration obtained under the working-plan method, but the cost (a very important matter) is very considerably reduced. Further experiments in this method are, however, necessary more especially in planting teak and other species with the *taungya* crops. The experiment of planting in new *taungya* (4) above has not been very successful. It should be repeated at an early date. Should it be found that planting with *taungya* proves to be successful—and I can see no reason to doubt that it will—the method to be adopted in the future will probably be to wait for the completion of extraction before regenerating the area and then regenerate by planting with *taungya.* It is extremely probable from the results already obtained that natural regeneration can be obtained after extraction of all girdled trees, *i.e.*, four years after girdling all seed-bearers, provided the area is successfully fire-protected to preserve the teak seed on the ground until it is required. This, however, is of minor importance if planting is to be done, as the natural regeneration will only serve as a supply of seedlings which can equally well be obtained from nurseries. I believe that in future natural regeneration will give way to artificial regeneration, as the latter is so much more certain and more easily tended. The chief problem which now remains to be solved is the method of introducing other species to form the mixture and the most suitable species to introduce. This will require some time. Indeed, the question cannot really be satisfactorily settled until the mixed crops have attained a considerable age. Species thought to be suitable in early years may not be found so later when the forest grows up and the same may be

said of the method of introducing the other species. This may be done in a number of ways, strips or lines alternating with teak is only one of many ways. One suitable method may very likely be to favour teak only in small pure groups, surrounded by forest of other species. Of suitable species I have already indicated a few, which I have experimented with. Yemane is too free-growing to mix in alternate lines with teak, but would seem to be suitable for strips or groups. Taungdama may also be suitable, but what is really required is a good shade-bearer to mix with the light-demanding teak, if any success is likely for a mixture in alternate lines. Such may possibly be Aukchinsa (*Dysoxylum*) or Eikmwè (*Lagerstrœmia Flos-Reginæ*) though probably neither could really be defined as true shade-bearers. There are, however, many others to be tried. I must leave this to my successors. It is one of the drawbacks of a forester's life that he is never able to see things through to the end, especially in this land of frequent transfers. I count myself extremely lucky to have been allowed six years in peace to study these interesting problems of regeneration of our most important species in a particularly favourable locality.

THE PRODUCTION OF FIRE.

BY W. H. CRADDOCK, P.F.S.

The following note was inspired by my coming across in an old copy of the *Scientific American*, dated 31st August 1907, an interesting article entitled "Striking a light" by Percy Collins. In this article, which is profusely illustrated with reproductions from photographs, Mr. Collins gives the early history of fire and describes the various ways in which fire may be produced by the friction of wood (*a*) by "ploughing" with the grain, (*b*) "sawing" across the grain and (*c*) "drilling" a pointed stick within a wooden socket. The sawing method is used in many parts of Burma and Mr. Collins describes the process as follows :—

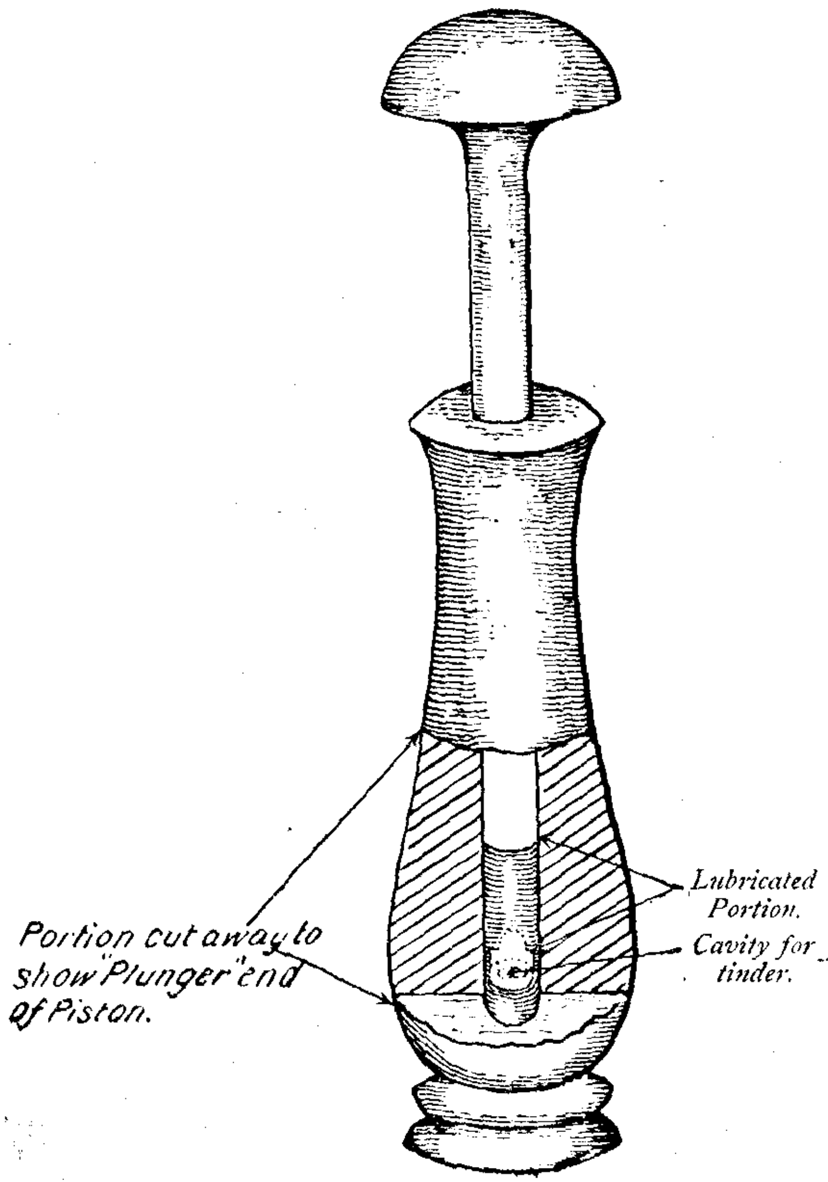
"Fire-making by sawing was a Malay device and has never perhaps been successfully employed save in countries where the

bamboo flourishes, the reason being that bamboo is the only really suitable wood. Two pieces are taken, one with a sharp edge, the other with a notch cut in it, nearly, but not quite, severing the substance. After sawing for a time, the floor of the notch is completely pierced and the heated particles fall below and ignite." I would add that the secret lies in continuing the sawing for a good 10 or 15 seconds after the smoke appears, otherwise one's efforts end literally "in smoke." Some fine dry bamboo shavings should be previously placed under the notch to receive the smouldering dust which results from the friction. The bamboo must be dry and strong enough to withstand a fair amount of pressure during sawing. Fire can be got in 30 seconds or less. The sawing must be continuous and pretty hard; indeed, it is quite an exertion—so much so that a doctor friend to whom I once showed the trick said :—" What a waste of energy! I have a much easier way," and forthwith he procured and placed a pinch of crushed Potassium permanganate crystals on a board, added a couple of drops of ordinary toilet Glycerine and on the fizzling mass put a small 'fid' of cotton wool, when lo! it broke into flame. Truly a miracle and a triumph of Science over the craft of the woodman! The old belief of forest fires originating from the chafing of wood stems may be said to be exploded, at any rate I do not think it will be held by anyone who has obtained fire by the sawing method.

Under the head of friction would presumably come "flint and steel," the friction igniting the inflammable or, I may say, explosive particles of steel and the sparks being caught by the tinder. (That steel does possess this property may be easily seen by sprinkling a pinch of steel, or iron, filings on a match flame when a pyrotechnic shower of stars will result.)

A method of fire production which is practised in the Kachin country—and I believe also in the Malay Archipelago—is not mentioned in Mr. Collins' article, namely, by compression of air. I have read somewhere that if air be suddenly compressed to a fifth of its original volume, the heat generated is sufficient to ignite tinder. Evidently this fact was known to certain uncivilized tribes

ages ago and resulted in the contrivance described below and known to the Burmese as ," Mi-zôn" or "fire-press" (see sketch below).



It is simply a compressive air-pump. A solid piece of buffalo horn an inch or so in diameter} and 4″ long has a hole $\frac{1}{3}$″ in diameter drilled longitudinally to a depth of 3″ : this is the piston box. Another piece of horn 5 inches long is fashioned with a straight shank a shade less than $\frac{1}{3}$″ in diameter and about 4″ long ending in a blob like a door-knob: this is the piston. The "Plunger" end has a small cavity $\frac{1}{6}$″ in diameter and $\frac{1}{4}$″ deep scooped in it and into this the tinder is pressed with a pointed splint of wood. To make the piston air-tight, strong thread is wound round for $\frac{1}{2}$″ near the thin end, and this is lubricated with thick grease or a mixture of bees-wax and any oil. To obtain a light, the piston is struck home with a sharp blow of the palm and at once extracted. If this is done correctly the tinder will be found to be ignited. The smouldering tinder is carefully picked out, fed with more tinder and finally fanned into a flame. The first apparatus of this kind I used was of Padauk wood but it apparently had a flaw, or the wood was too porous; any way, I only succeeded in getting fire twice after about a couple of hundred strokes and then the piston broke. I now have one of buffalo horn and with it fire is a certainty at every stroke. It should be mentioned that the kind of tinder used is important. *Bombax* cotton plucked just before the capsules dry and burst, thoroughly dried, appears to be the best. A little charred tinder mixed with it increases ignition. This tinder is also used with flint and steel. Another useful tinder is the tomentum at the base of the sheath of the *Caryota* palm. In the Himalayas a substance called "Kapasi" is used with flint and steel. It is a peculiar Papery tomentum which is stripped off the under-surface of the leaf of a small herb (*Gerbera lanuginosa*, Benth.).

In the article alluded to, Mr. Collins traces the development of the modern safety-match through the stages of the "Oxymuriate match," "Promethean match" and "Lucifer match." Apparently the first practical lucifer match was not invented till 1827 and the price per box at that time was a shilling. Though "safe" to all intents and purposes I might add that most brands of

safety matches can be struck successfully on a pane of glass—the match being held close to the head and swept with fair pressure over the glass surface.

NOTE ON THE GALLS OF *PISTACIA INTEGERRIMA.*

BY PURAN SINGH, F.C.S., CHEMICAL ADVISER TO THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

There is some doubt as to the percentage of tannin in the galls of *Pistacia integerrima*, known as *Kakrasinghi* in vernacular. These galls are available in the Amritsar market at about Rs. 10 per maund of 82½ lbs. They have been reported in Agricultural Ledger No. 1, 1902, to contain as much as 75 per cent. of tannin. This percentage seems to have been accepted by all the subsequent authors from what is given on the subject in Dymock's "Pharmacographia Indica," Vol. 1, page 376. If the galls contained as much as 75 per cent. of tannin or anything near as much, they would certainly be of incalculable value to the tanning industry, representing virtually a natural tan-extract.

With a view to verifying the figures given in the abovementioned text-books, a sample of *Kakrasinghi* was obtained through the good offices of the Divisional Forest Officer, Kangra, who also sent samples of the leaves and bark of the tree. These three samples were examined with the following results :—

	Moisture per cent.	Soluble solids per cent.	Non-tannin per cent.	Tannin per cent.	Tannin calculated on dry material per cent.
1. Galls of *Pistacia integerrima* obtained from the Divisional Forest Officer, Kangra Division, Punjab.	9·12	41·28	20·98	20·30	22·33
Leaves of the same ...	12·23	32·88	16·68	16·20	18·46
3 Bark of the same ...	8·93	18·08	9·72	8·36	9·18

The difference between 20·98 per cent. as compared with 75 per cent. previously recorded is so great that it seemed doubtful whether the sample received from Kangra represents a fairly average specimen of *Kakrasinghi.*

Accordingly, the writer went to the Amritsar market and obtained, from a heap of a few maunds of the article, an average sample of about 20 lbs. This sample was then examined for tannin with the following results :—

Moisture per cent.	Soluble solids per cent.	Non-tannin per cent.	Tannin per cent.	Tannin calculated on dry material per cent.
9·18	40·80	21·70	19·10	20·80

The two different samples of *Kakrasinghi* obtained from two different sources have almost the same percentage of tannin. This proves that the average sample of *Kakrasinghi* has only about 20 per cent. of tannin. The authors of the "Pharmacographia Indica" had examined a sample of this material by an old method of analysis, which has since been declared unreliable. The variation being so great, it is unlikely that they examined an exceptionally rich specimen.

The leaves when collected in winter were quite ripe, and were found to be fairly rich in tannin, containing about 16 per cent. It is possible that the leaves may be found to contain varying percentages of tannin at different periods of growth, and much more than 16 per cent. in a particular season. If so, it will be worth while creating plantations of this species which yields two fairly rich products, *i.e.*, galls and leaves, while the bark is too poor for economic consideration.

THE OBJECTIONABLE TIN CAN.

The following article headed "The dangerous tin can" appeared recently in the *American Scientist* :—

"The expert malaria investigators of the United States Public Health Service have found that discarded tin cans containing rain-water are breeding places for the mosquito which is the sole agent in spreading malaria. Tin cans should not be lett about the yard of the home or factory; for they may lead to sickness and even death. But if cans cannot be disposed of and must be kept in the premises, each can should be punched with one or more holes in its bottom so that it will not hold water."

The undersigned recently spent the hot weather and rains in Maymyo (Burma), which, in spite of being a hill station, can give points to some plains stations as regards prevalence of mosquitoes. These mosquitoes, though annoying and relentless blood-suckers, do not propagate malaria. They belong to the genera Culex and Stegomyia. They were found breeding almost exclusively in tubs and other vessels of water left lying exposed in or near compounds but especially in old tins, numbers of which are usually found thrown away in the jungle near each bungalow. No larva of malaria-propagating mosquitoes (*Anopheles*) were found breeding in these tins and, in fact, it is unlikely that they ever do breed in such receptacles. *Anopheles* larvæ are usually found among water weeds along the banks of sluggish streams. There are many suitable breeding grounds for *Anopheles* in Maymyo; but, fortunately for some reason, this genus is not common there. It would certainly make Maymyo and other similar stations more attractive if steps were taken to eliminate the tin nuisance.

B. B. OSMASTON, I.F.S.

EXTRACTS.

A FOSSIL WOOD FROM BURMA.

(*Illustrated.*)

BY MISS RUTH HOLDEN.

The extraordinary abundance of fossil wood to be found in Upper Burma has been noticed by all travellers in that region from the time of Crawfurd's visit in 1827[1] to the present date. So striking is its occurrence that the beds in which it appears were long known as the "Fossil Wood Group." More recently, however, a certain number of specimens have been found in the underlying Pegu series, so, to make the distinction between the two series clear, the name of the upper one has been changed to Irrawadian. As regards age, the former is referred to the Oligocene or Miocene; the latter to the Pliocene. The manner of preservation has been a subject of more or less controversy, Buckland[3] states that part is calcified and part silicified; Theobald[4] asserts that "none of the fossil wood is mineralized by calcification," and this observation is confirmed by Oldham.[5] Pascoe,[2] however, says that both types of petrifaction are to be encountered, though the former is the more common. The nature of the wood has always been a mystery. Buckland[3] suggested that it resembles the tamarind, but presented no evidence pointing to such a conclusion. On the other hand, the natives of Pegu[6] claim to be able to recognize two varieties, one of which they identify as the modern Enjin tree (*Hopea suava*) and the other as the Thiya (*Shorea obtusa*). In order to settle the matter, Theobald in 1867 sent some specimens to the British Museum for microscopic examination, but the preservation proved to be so unsatisfactory that it was only possible to ascertain that it was exogenous, not coniferous. Even in 1895, Noetling[7] comments on the fact that though quantities have been brought to England,

[1] Crawfurd, 1827. [2] Pascoe, 1912. [3] Buckland, 1828. [4] Theobald, 1873. [5] Oldham, 1855. [6] Theobald, 1869. [7] Noetling, 1895.

no scientific investigation has hitherto been made. In 1914, however, Mr. F. W. Cuffe presented to the Sedgwick Museum, Cambridge, a calcified specimen from Gwedindon in the Sagaing District. This was submitted by Dr. Arber to the writer for sectioning, and although the condition of the tissues leaves much to be desired, it is believed that its miscroscopic structure may be made out with sufficient detail to warrant description.

The material consists of two blocks, each about ten inches long, composed exclusively of secondary xylem. In the hand specimens, the annual rings appear to be well marked, averaging from ·3 to ·9 cm. in width but, as will be explained later, one cannot be sure that these correctly represent yearly increments of growth.

When studied microscopically, the preservation is seen to be very uneven, indicating that the wood had partially decayed before petrifaction took place. By a careful examination of selected areas, it is possible, nevertheless, to ascertain the structure in considerable detail. *The general features of the transverse section* are indicated in Plate 23, figs. 1 and 2. The vessels are very large and are scattered uniformly throughout the wood, without the differentiation into spring and summer elements characteristic of ring porous woods. As a rule, they are isolated, though at times they form radial groups of rarely more than three or four. The walls are comparatively thick, and abundantly pitted, especially where they are in contact with the cells of the rays. The character of the end walls could not be made out, but the study of living woods indicates that this is not a feature of any great diagnostic importance. Thus, while the more primitive types, such as *Betula* and *Alnus*, generally have scalariform openings, and the higher ones—the Leguminoseæ—have one large pore, many of the Fagaceæ combine both types. An extremely constant feature, however, is the abundance of tyloses which seem to fill completely the lumen of every vessel These usually contain a dark resinous substance.

The rays contain this same substance, which causes them to stand out in the photographs. As shown in figures 2 and 3, they

are ordinarily one cell wide, and vary from six to twenty cells in height. In the radial sections (figs. 4 and 5), the individual cells are seen to be rectangular in shape, while those on the margins not infrequently tend to become higher and more nearly square than those in the centre. Indications of such a condition may be discerned on the lower margin of the ray shown in fig. 4, but it is far from being universal.

Wood parenchyma is very abundant, and occurs in two definite positions, around the vessels and in tangential rows. In general, the vessels are so large and the rays so close, that each vessel is necessarily bounded radially by a medullary ray. Tangentially there are always wood parenchyma cells, thus ensuring a parenchymatous jacket completely encircling each vessel. This probably explains to some extent the uniformly tylosed condition of the vessels; it is represented in transverse section by fig. 2; in longitudinal by fig. 5. The occurrence of wood parenchyma in tangential bands of two to four cells is equally constant (see figs. 2 and 5). A striking feature is that these bands are nearly always double. In the description of gross specimens, it was mentioned that annual rings appear to be very clearly marked, but when subjected to microscopical examination, it is apparent that these "annual rings" are not formed by any difference in the size or thickness of wall on the part of the tracheides, but by these bands of tangential parenchyma. It is probable that at the close of each year's growth, the cambium laid down parenchyma cells, as in many of the living Leguminoseæ, etc.[1]; but in view of the irregularities known to exist in the formation of annual rings by the tropical woods of to-day, it appears safer to leave the question open.

One other feature of this wood requires mention, but unfortunately the state of preservation renders a definite statement impossible. In the lower part of fig. 1, a tangential series of cavities may be seen; a single cavity is shown in longitudinal section to the left of the vessel in figure 5. Superficially they resemble the resin canals formed in many conifers as a result of

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[1] Holtermann (1907).

wounding, or the "gummusis" of certain Rosaceæ. A closer parallel is probably afforded by the tangential bands of secretory canals found in many of the Dipterocarpaceæ. They occurred but once, however, in the material sectioned, and unfortunately in one of the least well preserved regions.

To sum up, the salient points in the anatomy of this wood are :—

(1) Vessels large, isolated, uniform in size throughout the year's growth, usually completely tylosed, and often filled with resin.

(2) Rays one cell wide, six to twenty cell high, very resinous, marginal cells often higher than those in the centre.

(3) Wood parenchyma vasicentric, and forming tangential bands.

(4) Tangential rows of secretory canals (?).

We come now to a consideration of the systematic position of this wood. As noted above, the two previous suggestions have been to the tamarind, and to the Dipterocarpaceæ. In microscopic structure, there seems to be little reason for the former reference, and the fact that *Tamarindus* is not indigenous in Burma,[1] renders this suggestion improbable. As regards the Dipterocarpaceæ, there is much to be said for this view. Through the kindness of Dr. Dawson of the Cambridge Forestry School, the writer was enabled to examine specimens of *Hopea odorata* and of various species of *Shorea*, and though specific identification with the fossil was not possible, they are clearly all of the same general type. The best description of the wood of the Dipterocarpaceæ is given by Brandis and Gilg.[2] According to them, there is an abundance of resinous substance in the resin canals, rays, wood parenchyma and vessels; the rays are up to six cells wide, and consist of "liegenden und stehènden Zellen"; the vessels are large, usually isolated, rarely in radial rows; the resin canals are often in concentric circles, but are frequently sparingly present. With

[1] Brandis, 19 6, p. 253.

[2] Brandis and Gilg, in Engler and Prantl., 1895, III 6, p. 266.

regard to the individual genera, *Shorea* seems nearest to our fossil, with "Gefässe meist einzeln ; Markstrahlen fast ganz aus liegenden Zellen bestehend, mit einzelnen kubischen Zellen aus oberen und unteren Rande. Holzparenchym um die Gefässe und in feinen 1-schichtigen Querbänden zwichen den Markstrahlen." Solereder[3] states that the rays of the Dipterocarpaceæ are 3—5 seriate, and the wood parenchyma abundant; while Guérin[4] comments especially on the large number of tyloses in the vessels. According to his observations, the resin canals are extremely sporadic, being sometimes entirely absent. To sum up, the features in which this Tertiary wood resembles that of the living Dipterocarpaceæ seem to be—

(1) Vessels large, usually isolated, abundantly tylosed, and filled with resin.

(2) Rays highly resinous, marginal cells higher than the central ones.

(3) Wood parenchyma tangentially banded, and vasicentric.

(4) Resin canals lacking, or in tangential rows.

Recent work on the comparative anatomy of angiosperm woods has emphasized the diagnostic importance of the position of the parenchyma, and on that character alone, one would be almost justified in referring this specimen to the Dipterocarpaceæ. The only discrepancy is the width of the rays, which according to descriptions referred to above, are at least three cells wide. In one species, however, *Shorea polyspermea*, I found them often uniseriate, and rarely more than di- or tri-seriate. This character, moreover, is always variable often within the genus,—*e.g.*, both *Salix* and *Populus* contain uniseriate and diseriate rayed forms.[1] As some evidence corroborating the reference of this wood to the Dipterocarpaceæ Heer's description of *Dipterocarpus verbeekianus* and *D. antiguus*,[2] from the Tertiary of Sumatra, is of interest.

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[3] Solereder, 1899. [4] Guérin, 1907. [1] Holden, 1912. [2] Heer, 1883.

We may then appropriately call this fossil *Dipterocarpoxylon burmense*, with the characters defined above.

In conclusion, I wish to thank Dr. E. A. Newell Arber for an opportunity to describe this wood; Dr. Dawson of the Cambridge School of Forestry for specimens of living representatives of the Dipterocarpaceæ; and Professor A. C. Seward for kindly reading the manuscript.

LITERATURE CITED.

Buckland, W.—Geological Account of a Series of Animal and Vegetable remains and of the rocks collected by J. Crawfurd, Esq., on a voyage up the Irrawadi to Ava, in 1826 and 1827. *Trans. Geol. Soc.*, Ser. 2, Vol. 2, 1828.

Brandis, D.—*Indian Trees.* London, 1906.

Brandis, D. and Gilg, E.—In Engler and Prantl.; *Die Naturlichen Pflanzenfamilien* III-6. Leipsig, 1895.

Crawfurd, J.—*Embassy to the Court of Ava in* 1827.

Guérin, M. P.—Contribution à l'étude anatomique de la tige et de la feuille des Dipterocarpées. *Bull. Soc. Bot. de France.* Mem. 11, 1907.

Heer, O.—Beiträge zur Fossilen Flora von Sumatra. Neue Denkschriften d. allegimen schweiz. *Gesell f. d. Naturwissenschaften.* Zurich, 1883.

Holtermann, C.—*Der Einfluss des Klimas auf den Bau der Pflanzengewebe.* Leipsig, 1907.

Noetling, F.—Tertiary System in Burma. *Rec. Geol. Soc. Ind.*, Vol. XXVIII, p. 2, 1895.

Oldham.—Irrawadi Valley above Ava in Appendix A of Col. Yule: *Narrative of the Mission to the Court of Ava in* 1855.

Pascoe, E. H.—Oil Fields of Burma. *Mem. Geol. Surv. Ind.*, Vol. XL, Part 1, 1912.

Theobald, W.—Geology of Pegu. *Mem. Geol. Surv. Ind.* Vol. X, p. 8, 1873.

Theobald, W.—On the Beds containing Slicified Wood in Eastern Prome, British Burma. *Rec. Geol. Surv. Ind.*, Vol. 2, 1869.

Solereder, H.—*Systematisch Anatomie d. Dicotyledonen.* Stuttgart, 1899.

DESCRIPTION OF PLATE.

FIG. 1.—Transverse section, showing tangential series of resin canals (?).

FIG. 2.—Transverse section, showing vessel filled by tyloses; narrow medullary rays, parenchyma vasicentric, and in tangential bands.

FIG. 3.—Tangential section, showing narrow rays, an d tylosed vessel.

FIG. 4.—Radial section, showing character of rays, and wood parenchyma.

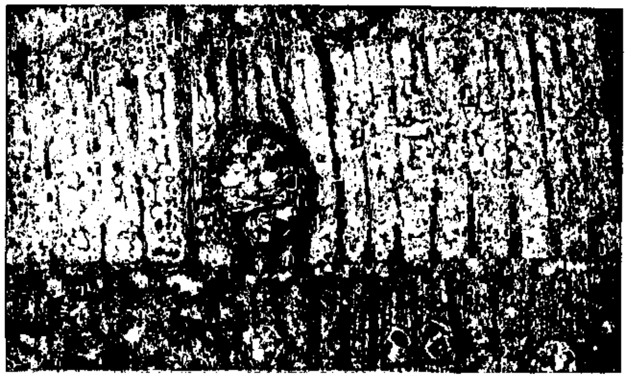
FIG. 5.—Radial section, showing tylosed vessel, and vasicentric parenchyma.

[*Records of the Geological Survey of India*, Vol. XLVII, Part 4.]

THE FLORA OF MADRAS.

The Flora of Madras, of which the opening instalment (pp. 1—200) dealing with the natural families *Ranunculaceæ* to *Aquifoliaceæ* has been issued, forms one of the series of local Indian Floras, the preparation of which was undertaken on the completion of the *Flora of British India* prepared at Kew by Sir J. D. Hooker during 1872—97. The author, Mr. J. S. Gamble, who was compelled to defer the inception of the task owing to his having undertaken to collaborate with the late Sir G. King in the preparation of the *Materials for a Flora of the Malayan Peninsula* and to his public spirited determination to continue that work after the death of his colleague is, by reason of his service in the Madras Presidency during his career as an Indian forest officer and his personal knowledge of the vegetation of a considerable portion of the area dealt with, especially competent to carry this new undertaking to a successful issue. That he has been able to supply a substantial instalment so soon is due, as the author explains in the introduction to part I, to the circumstance that he had the assistance of Mr. S. T. Dunn, formerly Superintendent of the Botanical and Forestry Department, Hong Kong, in preparing the draft of the botanical portion of the first 132 pages, to the end of *Biophytum*, and that for the genus *Impatiens*, which follows, the results of the patient study to which Sir Joseph Hooker devoted the last years of his life were available for use. Owing to his other engagements the assistance of Mr. Dunn is no longer available and the rest of the task is therefore being undertaken by Mr. Gamble alone.

A FOSSIL WOOD FROM BURMA.



1.

2.

3.

4

5.

W. Tams, Photo.

(Reproduced by kind permission of the Director, Geological Survey of India.)

Dipterocarpoxylon burmense.

The method of presentation adopted is that followed in the corresponding work for Bengal, issued in 1903. The object of that method is to enable the ready identification of a species in the field by enabling the collector to ascertain with certainty the genus to which a plant belongs and, this object attained, by limiting his attention to those characters of the plant under examination which are necessary to its specific determination. This method has the advantages of saving space and time, both matters of consequence to the traveller. The work is exceedingly well printed and an examination of its descriptions and keys indicates that it should serve its special purpose well.—[*Kew Bulletin*, 1916.]

THE CONIFER LEAF OIL INDUSTRY.*

THE SPECIES USED AND METHODS OF PRODUCTION EMPLOYED

BY A. W. SCHORGER.

The production of oils from the leaves or needles of various conifers is a small but fairly old industry in the United States. According to the best estimates obtainable, the value of the oils produced annually from this source amounts to approximately \$50,000 (Rs. 1,50,000). The leaves of only a few species of conifers are regularly distilled for their oils, since it is only for these oils that a steady demand has been created.

The principal species employed are the black spruce (*Picea mariana*, Mill.), white spruce (*Picea canadensis*, Mill.), eastern hemlock (*Tsuga canadensis*, Linn.), red juniper (*Juniperus virginiana*, Linn.), and arbor vitae (*Thuja occidentalis*, Linn.). The oils of white spruce, black spruce, and hemlock are very similar in composition. No attempt appears to be made to keep the leaves of the latter species separate, and for practical purposes a distinction between them seems unnecessary.

The annual consumption of spruce and hemlock oil is estimated at 40,000 to 50,000 pounds. It is quoted at \$0·45 to \$0·6 (Re. 1·35 to Re. 1·80) per pound. The leaf-oil of the red juniper

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* Metallurgical and Chemical Engineering.

is used largely in insecticides, the annual consumption being 15,000 to 20,000 pounds. The prices of the oils from the various native conifers are approximately the same as that given above. The oil of *Pinus picea*, imported from Europe, is sold at about $4 (Rs. 12) per pound, but the annual demand is below 50 pounds.

YIELDS OF OIL FROM VARIOUS SPECIES.

The oil is found in longitudinal ducts running through needles. The number and size of the oil ducts vary greatly with the different species, and on these factors the yield of oil is largely dependent. The number of oil-ducts may vary from one to ten. Naturally the species containing numerous ducts of large size will give the largest yield of oil. This assumption has been verified in the various species examined.

The long leaf pine needle contains five large oil-ducts, the average yield of oil being 0·42 per cent, while the lodgepole pine needle contains two oil-ducts, the average yield of oil being only 0·16 per cent. In all cases the yields are given in per cent. of the weight of the green leaves.

The approximate yields and principal constituents of the various species are given in Table I.

PROPERTIES, COMPOSITION AND USES.

As a general rule the oils have a pleasant odour, resembling the fragrance of coniferous forests. Occasionally the freshly distilled oils have a disagreeable odour that frequently improves with age.

The oils are composed mainly of terpenes, terpene alcohols and their esters, and sequiterpenes. (See Table I.) Among the terpenes, pinene and limonene are ordinarily present. The attractive odour of the oils is due mainly to borneol and its acetic ester. In general, the more highly prized oils contain large amounts of borneol, both free and combined. Spruce and hemlock oil contains 35 to 50 per cent of these constituents. The popular Siberian needle oil, of which 5,000 to 10,000 pounds are imported, contains from 29 to 39 per cent bornyl acetate. Among the

sesquiterpenes cadinene occurs most commonly. Thujone is a characteristic constituent of thuja oil from *Thuja plicata* and *Thuja occidentalis.*

It is difficult to obtain direct information on the purposes for which the various oils are employed. A large amount of correspondence addressed to manufacturers purported to use these oils in their products afforded very little information. Information on the uses to which the oils are put was obtained mainly from dealers and distillers of the oil.

The spruce and hemlock oils are extensively employed as a perfume in greases and shoe blackenings. It is also used in considerable quantities in liniments and other medicinal preparations.

Cedar oil from *Juniperus virginiana* is employed mainly in insecticides. Thuja oil from *Thuja occidentalis* is used in insecticides and liniments. Various native and foreign oils are employed medicinally, as inhalation for lung diseases, and as additions to baths and ointments in rheumatic afflictions. Various perfumes contain certain amounts of needle oils whose value consists in having a so-called "ozonizing" effect. The oil of *Pinus montana* mixed with chloroform is used in quantity as an embrocation. In Europe, especially, the finer needle oils are used extensively as perfumes in soaps.

DISTILLERS OF OIL.

The greater portion of the oil is distilled by small farmers in New England during the winter months when the farm work is slack. In 1912 a company in Seattle, Wash., was engaged in the distillation of the leaf oil of red cedar (*Thuja plicata*) on an extensive scale. The branches, three-quarters inch or less in diameter, were delivered in Seattle in bundles of 100 pounds at a contract price of \$4·50 to \$5·50 (Rs. 13-8 to Rs. 16-8) per ton, depending on their oil-content. The material was packed in the stills and distilled with steam at a pressure of 40 to 90 pounds for three to five hours, the distillation being discontinued when the amount of oil coming over did not exceed 10 cubic centimeters in five minutes.

The average yield of oil was about one per cent. of the weight of the green material. Young trees contained the largest amount of oil, and the leaves were richest in January, February and March. The oil had a market value of $0·40 (Re. 1·20) per pound, but this was scarcely sufficient to cover the cost of production. Most of the oil was employed in the manufacture of an insecticide called "Mothine." This was a dry powder containing about 35 per cent. of cedar oil and 65 per cent. of an absorbent made by nitrating the finely ground shells of peach pits.

Attempts have been made at various times to utilize pine needles for the production of fibre after the oil had been removed by distillation. The most ambitious attempts in this direction were made by C. M. and O. C. Terrell of Grants Pass, Ore., who obtained patents covering methods and apparatus. The plant, described by Brown,* utilized leaves systematically picked from young trees of the Western yellow pine. The stills consisted of wooden tanks with steam connections, and had a daily capacity of 2,000 pounds, from which ten pounds of oil were obtained. After suitable treatment the spent needles produced a long, tough fibre that could be woven into fabrics or made into mattresses when mixed with hair.

FOREST SERVICE INVESTIGATIONS.

The large amount of lumber cut from coniferous woods renders available large quantities of needles and twigs that at the present time are not only a sheer waste, but are frequently the cause of destructive forest fires. If a sufficient market could be created for the oils a great economic advance in management would be effected. At present, however, the demand and price for oils of this type do not warrant their manufacture on a large scale.

The leaves of a number of the most important Western and Southern conifers were distilled to determine the yield and chemical composition of the oil. Samples of these oils were sent to various manufacturers for practical tests. The most promising oils, judged from odour, were those of long leaf pine and Western

* Scientific American, 84,344 (1901).

yellow pine. Unfortunately in nearly all the oils the ester content was low and their odours did not surpass those of the already firmly established spruce and hemlock oils. There appears to be an increasing utilization of conifer leaf-oils, and the creation of a demand for new oils, as well as the extension of markets for the common ones, may be anticipated. It is frequently difficult, however, to introduce a new oil on the market, even though it may have decided merit.

Principles of Distillation.

The oil is removed from the leaves by the familiar method of steam distillation, usually at atmospheric pressure. As the steam passes upward through the needles the oil volatilizes and the mixed vapours pass together into a cooling apparatus, where condensation takes place. The condensation products soon separate into a layer of oil and water, owing to their immiscibility and difference in specific gravity.

Factors Influencing Yield of Oil.

Steam distillation under pressure is more rapid and produces more oil than distillation at ordinary pressure. When steam at atmospheric pressure is employed a greater yield is obtained if the needles are cut into small pieces. In this way the oil ducts are more exposed to the action of the steam and more material can be placed in the still. Experiments have shown that a still will hold 25 to 50 per cent. more material when it is finely cut.

The largest yields are obtained from young trees. In New England cedar oil is distilled almost entirely from small trees growing in old pasture and abandoned fields. All trees growing in the open contain more oil than those in a normal forest stand. The season of the year also appears to have a considerable effect, the data available essentially agreeing in that the most oil is obtained during the winter and spring months. The leaves of the Western red cedar (*Thuja plicata*) were richest in January, February and March; the leaves of incense cedar were richer in February and November than during the intervening summer months.

THE STILL AND ITS OPERATION.

The experimental still used by the Forest Service was constructed in three parts. The cylindrical body of the still for holding the needles was 3 feet 6 inches in height by 2 feet 3 inches in diameter, and was made of 16 B. W. G. copper. The ends were flanged out and provided with iron rings 1¾ inches wide. The cover of the still and the top of the heating vessel were similarly flanged and provided with rings. The cover and base were fastened to the cylinder with malleable iron clamps.

In order to support the needles the inner base of the cylinder was provided with lugs upon which rested a removable frame covered with 20-mesh No. 25 B. W. G. brass wire. The exterior of the still was covered with several layers of asbestos in order to reduce radiation of heat and condensation of the vapours.

The heating vessel containing the water was 3 feet in diameter and 2 feet 1 inch high, and was constructed of 11-gauge copper. This vessel was provided with a ½ inch water gauge and a funnel attached to a hand lever stop for introducing water when necessary.

The condenser consisted of 20 feet of 1¼-inch copper tubing wound in a coil of 1½ feet internal diameter, placed in a galvanized iron tank 2 feet in diameter by 2½ feet deep. The condenser was connected to the still with an 8-foot copper pipe, in two sections, 2 inches in diameter.

A two-gallon aspirator bottle, having a brass syphon, served as a receiver.

The material to be distilled was first passed through a feed cutter, the needles and twigs being cut into lengths of one-half to one inch. When the chopped material was well packed into the still the charge varied from 350 to 500 pounds, depending upon the species. By filling the cylinder ahead of the rising column of steam, the needles are decidedly more compressible.

The distillation was continued at the rate of 2½ gallons per hour. At the end of seven to eight hours the quantity of oil fell to 5 to 6 cubic centimeters per hour, and the distillation was then considered complete.

TABLE I.

	Yield of Oil.	Sp. Gr. †	Principal Constituents.
Red pine (P. resinosa)	0·10 } ?	...	...
Pitch pine (P. rigida)	0·10 } ?		
White pine (P. strobus)	0·10	0·9012	α—pinene
*Longleaf pine (P. palustris)	0·40	0·8829—0·8849	*Camphene*, β—*pinene*, *borneol*, *cadinene*
*Cuban pine (P. heterophylla)	0·27	0·8877—0·8894	Camphene, β—pinene, borneol, cadinene
*Western yellow pine (P. ponderosa)	0·08	0·8718—0·8849	α—pinene, dipentene, borneol
*Sugar pine (P. lambertiana)	0·09	0·8676—0·8738	α—pinene, β—pinene, dipentene, borneol
*Digger pine P. sabiniana)	0·09	0·8517—0·8566	α—pinene, limonene
*Lodgepole pine (P. contorta) ...	0·23	0·8690	Phellandrene, β—pinene
*Red fir (Abies magnifica)	0·15	0·8665	Phellandrene, β—pinene, borneol
*White fir (Abies concolor)	0·13	0·8720—0·8777	α—pinene, β—pinene, phellandrene, borneol
*Douglas fir (Pseudotsuga taxifolia)	0·16	0·8727—0·8759	α—pinene, β—pinene, limonene, borneol
Red spruce (Picea rubens)	0·20	0·9539 at 16 deg.	Borneol, bornyl acetate
Black spruce (Picea mariana)	0·60	0·9274 at 19 deg.	Bornyl acetate, terpenes
White spruce (Picea canadensis)	0·10	0·9216	*Bornyl acetate, limonene* (?)
Hemlock (Tsuga canadensis)	0·40	0·9288 at 20 deg.	α—pinene, bornyl acetate
Balsam fir (Abies balsamea) Miller	...	*0·8881 at 20 deg.*	*α—pinene, bornyl acetate*
White cedar (Thuja occidentalis)	0·50	0·915 —0·930	α—pinene, fenchone, thujone, borneol
Western red cedar (T. plicata)	1·00	0·9305 at 25 deg.	Thujone, pinene
*Incense cedar (Lib. decurrens)	0·23	0·8655—0·8733	α—pinene, limonene, borneol, librocedrene
Red juniper (Juniperus virginiana)	0·20	0·887 —0·900	α—pinene, limonene, borneol, cadinene
Tamarack (Larix laricina)	0·15	0·8816	α—pinene, bornyl acetate

* Examined by author. †At 15 deg. unless otherwise stated.

The oils are dried and filtered through cotton baton or fine muslin, and are then ready for market. Sometimes they are subsequently rectified by dealers.

The small distillers usually employ apparatus constructed partly of wood. The leaves are placed in rectangular or cylindrical wooden tanks, while steam is introduced from a separate generator. The simple apparatus used by a New England distiller of cedar leaf-oil will serve as a type of the stills frequently employed. His description is the following: "A steam-tight box, 3 feet by 4 feet and 3½ feet deep, with a boiler-plate bottom, is set on a rock furnace. Inside of this box is a grating 4 inches above the bottom to hold the cedar up to the top of the grating; a pipe from the top of the box 10 feet long carries off the steam. This steam pipe runs nearly its entire length through a trough of water kept cold by running water. The condensed steam drops into a glass jar covered with cloth for a strainer."—[*Scientific American Supplement.*]

ODD SOURCES OF OIL.

German chemists are showing that great quantities of oil may be recovered from materials that have been largely wasted. Asparagus seeds contain 12 per cent. of oil; lime tree fruit, 9 or 10; elm tree fruit, 9 to 14; and horse-chestnuts and cherry-stones, a large proportion. Even apple-pips, pear-pips and canary seeds have an oil value. After the oil is extracted, some of the materials —such as horse-chestnuts—leave a residue that is suitable for cattle-fodder.—[*Capital.*]

WHAT IS KAPOK?

What is Kapok? With this as an interrogation the *Ceylon Independent* gives us some very interesting information regarding this product which, as it points out, ninety-nine people out of a hundred are ignorant of, yet without the slightest doubt kapok will soon be as generally known, its uses and purposes thoroughly understood, as such every-day articles as cotton and wool. For

kapok is destined to revolutionize many forms and manners of manufacturing articles of the greatest utility and public service, and in a myriad ways will be incorporated into numerous articles of common wear and service. Everything, like everybody, has its infancy, and kapok is still in swaddling clothes, but undoubtedly will mature and materialize into one of the most important gifts of nature for the use of mankind. It is really marvellous from what unthought of sources we reap and glean the necessities and commodities of life. Were it possible to study the derivation of the majority of things we should be simply amazed at the origin and pay the highest tribute to the ingenuity and wisdom which enable man to profit by their adoption. What, then, is kapok—a curiously strange name which certainly haunts the memory and is not easily forgetable? It is the product of a tree botanically classified as the *Eriodendron anfractuosum*, peculiar to the tropical belts of all Continents and very strongly in evidence in the islands of the South—Java, Madagascar, Indo-China, Brazil and the Ivory Coast—and in its native appearance presents the form of a shiny white floss or down not markedly different from any other similar vegetable growth, but it is wonderfully light, so light indeed that even in its raw state it is some six times lighter than cotton.

There are specimen articles of many varieties of clothing in which kapok is the principal constituent. One line very appropriately will excite interest and admiration, for it is so particularly suitable for the brave fellows in the trenches exposed as they are to the wet and cold weather. This is the "Tank" khaki trench hose, made of a pure worsted, seamless and elastic, interlined with a specially prepared kapok in the form of a soft full-fashioned cotton hose, impermeable to water, warmer than wool, yet incredibly light and forming just the very thing for the lads who are battling for freedom and liberty. The wearer of this hose could never be frost-bitten and could defy "trench feet." Chills should be impossible and an even temperature is preserved, and, above all, they are comfortable and pleasant to wear, keeping one "all of a glow." And when you remember that they are insect-proof you can imagine how grateful the soldier wearer would be.

Taking a general review and forming an approximate idea of the application to kapok, it should be emphasized that this material is six times lighter than cotton wadding, and so protects the body against loss of heat and energy without entailing weight. Another prominent use to which kapok is extensively put is for medicinal purposes, and doctors are widely recommending it for lining orthopædic appliances and as the best preventive against abdominal troubles, lumbago and neuritis. A garment lined with kapok, whether for travelling, general wear, or sports purposes, is a perfect protection against extremes of weather, both hot and cold, protecting the wearer against rain, sleet and wind, from chills, colds, influenza, rheumatism and ague, and yet imparting the utmost comfort without the semblance of weight. To summarize it can be definitely stated that carded kapok is proof positive against water, vermin, heat, cold, acid, damp and rot, and that it is the lightest and the warmest fleece in existence, permitting perfect ventilation, yet absolutely resisting all injurious attacks.—[*Indian Planters Gazette.*]

VOLUME XLIII NUMBER 9

INDIAN FORESTER

SEPTEMBER, 1917.

RAFTING AND MEASURING TEAK LOGS ON THE SITTANG RIVER, BURMA.

The work done by Divisional Forest Officers in all provinces of India is probably much the same, *viz.*, routine work and inspection tours—but the duties of attached officers in Burma are rather different from those of Assistants in India, in that they are mainly engaged in executive work connected with teak. From his first cold weather till he gets a division (nowadays, after 5, 6 or 7 years' time), the average Burma Forest Officer puts in every year 4 or 5 months girdling teak and 3 or 4 months measuring the rafted timber at one of the big measuring stations, Pakokku, Mandalay, or Toungoo. An account of the river work, which is familiar to all of us in Burma, may not be without interest to brother officers in India. The Toungoo work will be described, as the writer has had some years' experience of it.

2. The river Sittang drains the Toungoo forests (two divisions), and also those of the Pyinmana Division, in addition to parts of the Southern Shan States. The quantity of timber extracted

from the Shan States, however, is negligible compared to the amount turned out by the three big teak firms, *viz.*, the Bombay Burma Trading Corporation, Ltd., Steel Bros. and Co., Ltd., and Macgregor and Co., from the three divisions. The outturn naturally depends on the rains and fluctuates considerably but, in an average year, about 50,000 to 60,000 logs arrive at Toungoo or smaller depôts above and below. Of these the Bombay Burma Trading Corporation are responsible for about 10,000, Steels 10,000 and Macgregors 35,000 to 40,000. The latter firm has, by far, the largest area of forests in this drainage, the whole of the Toungoo Division being leased to them as well as a large reserve in Pyinmana. It will be seen, therefore, that the work of measuring is one of considerable magnitude. As a rule, there are four junior Imperial men posted to Toungoo for measuring, during the rains, one or two being usually newly joined men.

3. This account will only deal very shortly with rafting, since that is entirely undertaken by the firms and it is merely mentioned in order to make the account of the journey, from forest to mill, intelligible. Logs which reach the Sittang from its feeders come into it only when the feeders are in spate, and they are generally allowed to float into it quite uncontrolled. The lessees are given a suitable stretch of water in which to salve their timber. Below that limit it becomes *drift* timber, which may not be collected except by a Government Drift collector. The drift timber is released to the firm whose property mark it bears when it is claimed and a small fee has been paid to cover cost of collection, etc. In some cases, timber is held up by a boom at the mouth of the feeder and sent under control to the depôt below. In other cases, any villager on the bank who wishes, can catch logs as they float past and deliver his catch roughly tied together by creepers, rope, or fibre, to the agents of the firms at their various depôts. The firms pay the villagers varying rates for different sized logs. It is probable that the rates offered by each firm also vary, as cases have been known of villagers carefully selecting the logs they wish to salve and deliberately letting others go.

Rafting & measuring of Teak logs on the Sittang River, Burma.

Fig. 1. Rafts moored alongside bank for measuring.

Fig. 2. Front section of raft showing a heavy butt log attached *outside* the raft.

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 3. Measuring girths. Chalk marks on logs to

Photos. by T. W. Baird, Photographer.

Fig. 4. Hammering the measured logs with the

Arrived at the depôts, which are scattered up and down the Sittang, the logs are made up into rafts which will eventually be sent to Rangoon.

Rafting on the Sittang is somewhat different to that on the Irrawaddy, since the rafts have to pass through a canal from the Sittang into the Pegu river, and the canal authorities prescribe the maximum dimensions of rafts which are allowed to use it. In practice, this amounts to limiting the number of logs in a raft to about 30 or 35 large or 50 to 60 small and medium sized logs. The rafts are made up in sections securely bound together by cocoanut fibre rope laterally and by twisted cane longitudinally. The lateral fastening passes through drag-holes (Burmese " Năpā ") or similar holes made for the purpose, if there is no drag-hole suitably placed on the log already. As a rule, only the two outside logs and the centre one are connected longitudinally with the adjoining sections. On the front of the 1st section and back of the last section, a pole is securely lashed across the raft to small posts about one foot high, let into the logs themselves (see Plate 24, Fig. 2). Loops of twisted cane are fastened to these posts to serve as row-locks for the oars used in navigating the raft. The front section contains the heaviest and largest logs, each succeeding section being made up of smaller logs. Extra heavy or extraordinarily crooked and unmanageable logs are often simply attached by one end to the main raft. The reason of these arrangements is not very clear, but it is believed they are made on account of the river being shallow. If the front section floats safely over obstacles, it is odds on that, the others will follow without disaster. Each raft is provided with a small dugout boat, a bamboo hut, oars, etc., and a mooring cane. The rafting is usually undertaken by contractors who deliver direct to Rangoon, but Messrs. Macgregor have, of late years, done the whole thing themselves. In any case, the procedure is the same. About 20 rafts are handed over to a raft-"gaung" (*i.e.*, headman) who together with all the men employed in the industry is Burmese. The men from necessity are of almost amphibious habits. There is a staff of four men to each raft and they live, often with their families, on

the raft until they reach their destination. The raft-gaung is responsible for the rafts and their custody in transit and he usually provides all his own men, who return from Rangoon by train.

4. In this part of Burma, the rains set in about the beginning of June, and rafts are ready for measurement from the end of July onwards. When the river is very high (and it fluctuates enormously), nothing much can be done as the rafts would get carried over the banks in places and stranded. Again, in the reaches above Shwegyin, 180 miles or so below Toungoo, the water is very shallow after November, so that whenever conditions are favourable there is feverish activity to get the rafts made up, measured, and despatched. The measuring officers in consequence are much in demand at one time and have less to do at another. Government has ordered a shallow-draught launch for this work, but the War has prevented its delivery. After measurement, the ordinary removal pass is issued and the rafts start on their journey, which may take from one to three months, although it is usually accomplished within two. The distance by rail is 166 miles, but by river it must be at least double. Late in the season, the journey is complicated by frequent stranding, etc., and rafts occasionally do not arrive till the next season. Among other expedients adopted by the raftsmen is the cutting adrift from the raft of large and troublesome logs, and if they get tired of the job, it is no uncommon thing for them to tie up the raft and quietly disappear, leaving the logs to their fate.

Rafts are moored by a long cane attached to the raft at one end (see Plate 24, Fig. 1) and, at the other, to a pointed wooden staff 9 inches or 10 inches in diameter and 10 feet long. The cane is fastened to it above a shoulder about 18 inches from the pointed end of the staff. The staff is held by a man on the bank, who allows the point to plough up the ground until the moving raft is stopped, and the top end is then tied down to a peg or anything handy in order to prevent the staff being pulled out of the ground.

5. When ready for measuring, the completed rafts are strung out alongside as steep a bank as possible, in order that they may not be left stranded by any fall of the river, and each log has a

thin strip of cane or bamboo (Burmese "Hni") loosely tied round its approximate centre.

A measuring party consists of two gazetted officers, 6 or 7 subordinates, and a clerk; and, in an ordinary day's work, they get through 10 or 12 rafts, *i.e.*, about 500 logs. If more are measured, the clerk has rather a bad time of it, as he has to keep his cubical contents worked out up-to-date. Under their leases, the firms are allowed two deductions from the length, (1) the "snout" or felling wedge on any butt log is excluded from measurement, and (2) a length not exceeding one foot is deducted on account of drag-holes from one end of each log. In practice, the "snouts" are marked off by a white or red paint mark by the firms previous to measurement, and all that has to be done is to see each of these marks and to decide if it is a genuine butt log, and if the mark has been fairly placed on the log. It is quite common to find employees marking off felling wedges when the wedge has really been made to assist dragging often on what is obviously the smaller end of the log, and it is not uncommon to find a mark on both ends of the same log. Logs frequently have to be rolled over in the water in order to decide on the *bona fides* of the felling wedge. One of the measuring officers, usually the junior man, looks after this part of the work and also checks the actual measuring which follows. The logs, if they have not been serially numbered by the firm with iron number cogs, have a serial number written on them in chalk. The ring of the tape is fastened to a flat stick or piece of bamboo about one foot from the end and held at one end of, and at right angles to, the log by a subordinate. In the case of a log with a felling wedge, he puts the bamboo flat on the log, on the paint mark which has been passed by the measuring officer, and the length of the log is called out at the other end by the length-measuring subordinate, who is usually a reliable Deputy Ranger. The practice at Toungoo is to allow a foot in each case for the drag-hole, and so another subordinate writes in chalk the length *minus one foot*. At the same time, another man marks the exact centre of the log in chalk (Plate 24, Fig. 2). In this way the party moves across each section and they are followed by coolies who shift the "Hni's" (strips of split cane)

which have already been put on each log, into the exact centre as marked in chalk.

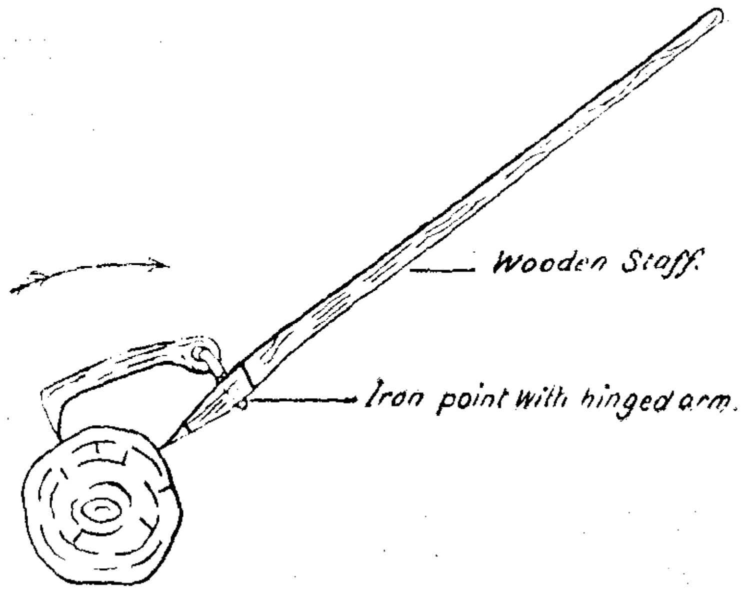
The girth-measuring party then follows. First of all, a subordinate calls out the serial number of the log and its length, from the chalked figures. These are taken down on a printed form by a clerk on behalf of the Forest Department and one (or two) on behalf of the lessees.

The girth is then measured by untying the "Hni" round the centre, pulling it tightly and evenly round the log with the ends crossed, when the two ends are severed by a man with one blow of a sharp axe or "dah." The "Hni" is then placed on a wooden measuring staff and the length called out by a responsible subordinate (see Plate 24, Fig. 3). This is booked by the clerks and the party moves forward.

6. All these operations are checked by one of the measuring officers and also by several clerks or agents of the lessees. At the end of each raft the books of the two parties are checked, and any difference at once reconciled by re-measurement. Cubical contents according to quarter-girth are worked out afterwards by both parties separately, and the totals personally checked by the measuring officer and the agent of the lessees. As a general rule, the girth of each log is written on it in chalk to assist the measuring officer who has to classify the logs and give allowances, but this is not necessary. The second measuring officer and a European agent of the lessees go over the measured logs one by one. The lessees point out any logs they think should be classified as refuse, and also defects for which they ask allowances. This is a very tedious business, as many logs have to be untied from the raft and rolled over in the water to allow of inspection. The rolling is done by men who lever the logs round by poles inserted into the drag-holes. Messrs. Steels use a Canadian log roller which greatly accelerates the work. A rough sketch of this instrument is given on the next page which explains the action.

All this takes a lot of time and is a contentious business which has been known to cause friction, since it is scarcely possible to lay down a hard and fast definition of a "Refuse" log.

According to the leases the firms pay royalty on three classes of timber, *i.e.*, "Full-sized" which is defined as containing 30 cubic



feet or over per log, "Under-sized" (under 30 feet) and "Refuse." In the two Toungoo Divisions, Messrs. Macgregor pay an all-round rate, so there is no question of classifying this timber. Each lease states definitely that no allowance can be claimed for hollows or other defects but, in spite of this, allowances are still given under the orders of the Local Government. There can be little doubt that this is wise. Unless encouraged in this way, lessees might be tempted to leave behind, in the forest, logs with defects which, under present circumstances, they bring out. Until our staff is strengthened to enable Divisional Forest Officers adequately to inspect lessees working, allowances should be continued. The task of classifying logs as "refuse" is no easy one, and I would here enter a plea for the better training of measuring officers. At present men are deputed to Rangoon to watch the sawing of Admiralty logs, *i.e.*, timber as nearly perfect as can be obtained. What we want is to send our newly-joined assistants into a mill for a time to study the utilization of unsound, crooked, and hollow logs. I believe any of the big firms in Rangoon would permit

such an arrangement if approached and the purpose explained to them.

The allowance made on each log, in cubic feet, is noted and the total entered in the measurement book at the end of the day. Formerly, it was the custom to give allowances in running feet. This method had the disadvantage that deduction might easily be made from the wrong number in the book and care had to be taken that no full-sized log was reduced to under-sized by reason of the allowance. On coming to an imperfect log, one first has to decide if it should be classed as "Refuse." If it is so decided, the number of the log is noted and entered in the measurement book later. If not "Refuse," some allowance will certainly be asked for. Individuals naturally vary, but the system on which these are given is roughly this: that we are selling timber—not holes, or pieces of shattered or rotten wood so that we have to estimate the number of cubic feet lost to the buyer on this account if he pays on the measured length and girth. In his calculation the measuring officer is assisted by the girth of the log and Carter's tables (tables which he usually carries in his head after a few thousand logs have been gone over). Allowances are not given for natural defects such as flutes or small external faults which are covered by the quarter-girth method of calculating cubic contents. In 1913 account was kept of the allowances given by 3 or 4 different officers, and at the end of the season, it was found that they only differed by ·1 per cent. or ·2 per cent. from each other. Having been classified and allowances given, the logs are hammered with the Pass hammer (Plate 24, Fig. 4).

7. This measuring and classifying occupies, on an average, ten Imperial men and 30 or 40 subordinates for four months every year in Burma and is, therefore, a costly business. It remains to be seen whether time will not bring forth some way, which is quicker and less expensive to both parties, of arriving at the amount of royalty due to Government.

At some distant date, when we have compiled reliable yield tables, it may be possible to sell the standing trees when girdled as was suggested some time ago by a writer in the *Indian*

Forester. Perhaps some one will invent an electrical crane which will lift each log out of the water and register the weight at the same time. This may seem unnecessary, but it should be noted that besides being expensive, the present system is not infallible. In fact, the writer is prepared to say that all present-day measuring (honestly done of course) is slightly inaccurate and in favour of Government. With logs lying in fast running water, the current carries the "Hni" away slightly under the surface, thus causing it to run round the log at an angle and to give a larger reading. Another factor is introduced by pieces of grass and rubbish which get caught in the "Hni" underneath the log and are never seen (any one who doubts this is asked to roll over a dozen logs with the "Hnis" on). Do not imagine the lessees are being defrauded; they know exactly what happens and tender accordingly. By giving a certain percentage as a fixed allowance, much time could be saved, and until some new method of measurement is devised, the writer urges a flat rate for all timber with a fixed allowance for defects, and the matter then becomes one of simple measurement.

Under the system in practice with Messrs. Macgregor's Toungoo logs, one gazetted officer only is needed in each party and the work is got through 50 per cent. faster. The saving to Government would, therefore, be considerable, and much greater to the lessees who, at present, have a large staff of men who examine each log prior to measurement and mark the defects on them in detail.

8. Written, as this is, entirely from memory and some time after the work was done, it is hoped that critics will forgive any inaccuracies which have crept in. The writer is much indebted to Messrs. S. E. Johnston and T. W. Baird, Forest Manager and Assistant, respectively, of Messrs. Macgregor and Co., for assistance and for the loan of the photographs illustrating this article.

JUNIOR.

MICA IN KODARMA.

BY I. B. MUKERJEE, P.F.S.

Situation.

Kodarma is situated in the Hazaribagh District of the province of Bihar and Orissa. It is about 5 miles north-east of the Kodarma Railway station, on the Grand Chord of the E. I. Railway, about 245 miles from Calcutta and at about 1,250 feet above sea-level. It is a small village, inhabited by a few hundred people, who belong mostly to the cultivating classes. They are mostly Hindus and speak a colloquial imperfect Hindustani. On account of the mica mining which centres around this village, it is very well known in Europe and America.

Early History.

Mica has been known in India from very ancient times, and its production is one of the long established industries. The Indians used mica for glazing and decorative purposes. From the Hindu Ayurvedic Sastras, we see its mention in Hindu medicines. It may be mentioned here that, in the old days, a primitive method of mining was followed, which merely consisted in digging out the surface deposits. Even up to recent times this primitive method has been followed. As the surface mica is gradually getting exhausted, scientific methods are beginning to replace the old mode of mining.

Recent History.

When the first European settlers came to Chota Nagpur, the people of Kodarma and other neighbouring villages were already extracting mica by the above method, and they used to exchange the mineral for grain, cloth, salt, etc., with the traders from Gaya, Patna and Benares. The industry, as it is now known, is of recent growth. About 40 years ago, Mr. Chrestien of Tisri first heard about mica from one of his overseers, and he began to quarry mica on a small scale. After considerable difficulties, on account of his not getting a good sale for the mineral, he at last succeeded in getting a very encouraging price for the mica which he sent to London.

By a coincidence, while Mr. Chrestien was seeking a market for his mica in the London market, an American electrician was in

search of an insulating material for his Dyanmos and Motors. When he found that mica served his purpose admirably, he discarded *asbestos* which he had been using as an insulator before mica. Encouraged by the good price for his mica, Mr. Chrestien began mica mining in more earnest; and, after he had been in the mica field for a few years, other companies made their appearance. They were chiefly Bengalis, and took up small areas of mica-bearing lands on short leases and worked them profitably, as working expenses were small on account of their working the surface deposits only. As time went on, other Europeans established themselves in the district, and the industry developed rapidly as may be seen from the following statement of revenue Government derived from mica :—

Year.		Revenue. Rs.
1887-88	...	... 285
1892-93	...	... 8,029
1914-15	...	... 30,736

The sole lessee up to 1890 was Mr. Chrestien, now there are about 22 lessees. The following are, perhaps, the chief mica-mining companies in Kodarma :—

Messrs. F. F. Chrestien & Co., Limited; The Chota Nagpur Mica Syndicate; Messrs. Tata, Sons & Co.; Messrs. Hoare, Miller & Co.; and Messrs. Sahana & Cousins.

Position and Extent of the Mica Belt.

The important mica-bearing area comprises a stretch of broken jungle-covered country; it extends from Monghyr District in the east to the Gaya District in the west. It is especially rich in the extreme northern portion of Hazaribagh District, *i.e.*, north of Kodarma village, in the Reserved and the Protected Forests of Kodarma Range (Palamau Division). The belt of mica-bearing country extends for about 55 miles in length east and west, and to a width of ten to fifteen miles. My remarks chiefly concern the above-mentioned Government Reserved Forests, which are very rich in mica.

Kodarma forest is situated on the borders of the Gaya District, and on the scarp of the lower plateau of Hazaribagh District. The elevation varies from about 1,250 feet near Kodarma to 500 feet on the Gaya boundary, but some of the hills attain 2,000 feet. The ground is broken up into numerous ridges and hills, and is separated by ravines and small streams which are usually dry in the hot season ; their sides are generally steep and rocky. The underlying rock is chiefly composed of schists and granites including pegmatite, in which the marketable mica occurs as well as tourmaline. The surface soil, in most places, is composed of quartz, felspar and mica ; on broad ridges one meets with a reddish clay which, in exposed places, is very hard. The average annual rainfall amounts to about 50 inches ; it varies from 64 inches in a good year to 32 inches in a bad year. The shade temperature varies from 49° F. in winter to 111° F. in summer. The Reserved and Protected Forests comprise 56·91 square miles in one compact block. The crop consists of Sal, Asan, Pial (*Buchanania latifolia*), mostly of a marketable pole size, and a large variety of other species. The hills and dry portions of the forest are full of bamboos (*Dendrocalamus strictus*), Saia (*Anogeissus latifolia*), Salai (*Boswellia serrata*), Galgal (*Cochlospermum Gossypium*), etc. Salai generally occurs on the most rocky ridges. The forest is a valuable one, and a working-plan for it is now in preparation.

Description of the Forest.

Mica, though a minor forest product, is at present the chief source of revenue to the Forest Department in Kodarma, but the settlement of mica-bearing lands is in the hands of the District Officer who disposes of all applications for Prospecting or Mining of mica. In the case of mining leases, the District Officer's powers are subject to the control of the Local Government. Any person, desirous of mining mica, must apply to the District Officer on stamped paper, after having provided himself with an approval certificate from the Local Government. In granting such a certificate, the Local Government satisfies itself that the person intends to carry out *bonâ fide* prospecting work, and has sufficient means at his

Prospecting Licenses and Mining Leases.

disposal. When the District Officer grants any person a prospecting license in respect of an area, an agreement is drawn up between the parties in a prescribed form which is registered. On receiving information, from the District Officer, as to the grant of a prospecting license to any person, the Forest Department demarcates the area on the ground, and gives the licensee possession of the same, and hands him over the license; from the date of possession, the license is current for one year. In special cases, prospecting licenses may be renewed for another year, at the discretion of the District Officer. Ordinarily, the prospector, if he wishes to continue to work the area after the expiry of the Prospecting License, would apply to the District Officer for a mining lease of the same area, and a lease for thirty years may then be granted in accordance with the rules for such leases. Among other conditions in the mica lease, the lessee binds himself to observe certain restrictions in the interests of fire-protection.

Map of Kodarma Forests and 40 acre Square System.

As already stated, there was only one lessee, up to 1890, who was allowed to work throughout the whole of Kodarma forests on a small annual rental; gradually, when other lessees began to appear, small areas were taken by them on short leases of five years. After the expiry of the short lease, mines were offered for sale by public auction on five years' leases. It is said that, by the auction system, Government once got as much as Rs. 10,000 for a mine of an area of less than half an acre. On account of the shortness of the tenure of a lease, mica lessees naturally could not develop their mines properly, as there was no certainty of the renewal of their leases when they expired. Since Government has decided to grant 30 years' leases, the chief European firms have begun to work some of their mines on scientific principles. They have sunk vertical shafts of 50 to 100 feet into the most promising seams, and have connected them underground by galleries at different levels. When the Mica Industry developed, the Government undertook to divide the whole forest of Kodarma into 40-acre squares; in five years (from 1901—1905), the whole forest was surveyed by the Forest Survey Staff, under

the supervision of Major P. J. Gordon, I. A., at a great cost. A good detailed topographical map of the whole forest in five sheets showing the 40-acre squares was published in 1906 by the Surveyor-General of India. These maps can be had, at the Dehra Dun Survey Office, on payment of Rs. 7 per set. Since the publication of the map, the settlement of mica lands is done by squares and this process has simplified the work of demarcation, and it has altogether stopped constant disputes amongst the mica lessees regarding the boundary of their mines. The system has also done a great deal to bring the industry within the reach of men who desire to lay out a small capital at a time.

Royalties and Rents.

For a prospecting license, the licensee has to pay, in advance, a yearly rent of four annas per acre, in addition to a fixed royalty at 5 per cent. on the value of the mica won by him. For a mining lease, the lessee has to pay a yearly ground-rent of Re. 1-8-0 per acre in half-yearly instalments. A few years back, the system was that a mining lessee would pay a royalty of 5 per cent. *ad valorem* on all mica won by him plus an annual rent of Re. 1 per acre. Under the present rules, the Local Government is empowered to re-introduce the old system of royalty and rent, after giving two years' notice.

Method of Mining.

The mica lessees generally depend mainly on local Sardars for the prospecting work. A few coolies are sent out, under an experienced Sardar, to prospect a certain area. The first thing they do is to dig trial pits, in places where the Sardar thinks that there is some outer indication of the existence of mica. While excavating trial pits, the prospectors get lots of surface mica which is more or less useless on account of its being soft, cross-grained and weather-stained. Sometimes, big "books" of mica are found in these trial pits, but they seldom produce any appreciable quantity of useful mica.

There is no hard and fast rule about the surface indications of the mica-bearing quartz known as a mica *vein*. The following are the indications which the local experienced men generally rely on :—

1. Presence of rock quartz on the surface ; sometimes these quartz masses prove to be barren.

2. Presence of pegmatite in the surface. Pegmatite is a rock composed of the primary minerals quartz, felspar and mica. Some other accessory minerals such as tourmaline, beryl and biotite or black mica, are often also found.

3. Presence of small mica crystals and small pieces of mica in the soil.

4. Sometimes the inner vein is visible from the surface; these veins are called Stringers, locally known as *dora*.

When the above indications are found, a prospector will make small trial pits to see if there is any mica underground. Generally, these trial pits are driven down 10 to 12 feet, and if no mica is found and if the surface indications disappear, they are abandoned. Sometimes, it so happens that the prospector is misled by the presence of mica crystals or a belt of quartz underneath; he continues the excavation work and, in many cases, the mica vein vanishes and he fails to get a mine. The pit that is expected to become a mine is generally full of pegmatite and this belt of pegmatite, or the *vein*, gradually widens and dips in the deeper soil, at last such a pit is declared to be a mine. Under the Indian Mining Act, any pit that has gone down deeper than 20 feet is called a mine.

In the old days, that is, long before the Europeans began to control the mica mining of Kodarma, the local people used to quarry mica in the following way. They used to get hold of one book of mica on or near the surface, another book still deeper and so on until the hole grew deeper. Mica books in the vein are not continuous, but are found isolated here and there; hence as the hole followed the course of the vein, it assumed a meandering course. As the hole grew deeper and deeper, women and children sat in a row on ladders or wooden scaffolds let into the sides of the pits, and passed up the waste material from hand to hand. Similarly they de-watered the pits where water accumulated. When the pit grew too deep for these methods, and it became dangerous for the coolies to work, or if the deposit on the lower side of the existing pit proved richer, they dug another pit lower down the hill slope until the original working place was touched. In this

way, they dug many holes from the surface, and these holes assumed all sorts of crooked courses. Vertical shafts or tunnels were never dreamt of then, as they did not know how to timber the shafts and the use of explosives was unknown to them. When a deposit proved to be very rich and wide, they made an open cut, and the waste was heaped on either side without any regard to drainage or slopes. It is said that the local miners of the past, known as "Mahajans," took down their mines to a depth of 60 to 80 feet; it is a mystery how they could do so without proper timbering and without the help of explosives. Even up to a recent date, that is, long after the Europeans took to mica mining, this system of working the mines has been followed. These mica pits cannot be called regular mines. From the surface one or two small openings, just wide enough for a man to enter, will be visible, and it would be very hard to tell that these pits have gone down to depths of 50 feet and upwards. Unless a man actually enters the pits and sees for himself their depth, it is not possible for him to know that such small openings are mouths of big mica mines. With the help of explosives, steam pumps, etc., modern mica miners have been able to drive long tunnels, vertical shafts, and air-holes, etc. Soft portions of a tunnel or a shaft are properly timbered to prevent their collapse. So far no mine is known to have gone down to a vertical depth of more than 200 feet.

The surface soil being generally soft, all prospecting work is carried on with chisel and hammer and pickaxes; when the vein grows wider and the rock gets very hard, the mining of mica is done with the help of explosives. In many cases, particularly in a pit which will become a mine, even prospecting work is done with the help of explosives. Commonly, isolated mica 'books' are found in between two layers of hard rock; in mining mica, this hard rock has to be broken and this is done by blasting. When the hard rock is broken, the mica 'book' is exposed and it is then scooped out by drills, chisels, etc., and brought to the surface where it is split into pieces of about 1/8" in thickness, and tied up in bundles of 15 to 20 seers and sent to the mica godown or factory. Mica being in layers, is very easily split into slabs. These slabs

of mica are roughly sorted by the miners at the mines; unsaleable pieces are thrown on the dump as waste mica. The bigger pieces are tied up in bundles known as medium bundles or "Mejla," and the small ones are tied up in small bundles called "Radi." Mica mining is very uncertain in its results: a vein, once giving abundant mica, has been known to disappear for good. When once a mine is started, the vein which contains isolated books of mica, does not always produce mica but, at times, the miner has to cut deposits of rock known as *faults* in the vein. In the cutting of these faults, the miner has to spend a great deal of time and money for "dead work," and in return gets no mica.

Labour.

The local villagers, or at least a large number of them, earn their bread by working in the mica mines; very few imported coolies, excepting a few Santhals, are found around Kodarma. The castes chiefly employed in mining are Ghatwars, Musahars, Bhooiyas, Goalas, Turias and Jolahas. About 20 years ago, rates of wages were: for an adult miner 2 annas per day, and for women and children 1 anna to 1 anna 3 pies per day; now, the wages for an adult miner range from 3 annas 6 pies to 8 annas per day, while the women and children get 1 anna 6 pies to 3 annas per day. About 2,000 coolies work daily in the mica mines of Kodarma forests; besides, many coolies work in the factories. During the rains very little deep mining is done, as then the mica pits become full of water, and most of the coolies go back to their cultivation. This is the time when mica managers carry on prospecting work with a few coolies. The industry is a great benefit to the local population, since the villagers, by working in the mines and factories, earn a decent wage, and they never feel the pinch of scarcity. Consequently, crimes, due to want, are not very common here. Yet, owing to the ready sale of mica to local dealers and the good money obtainable, it is a frequent complaint of the bigger and real mica mining managers that mica is pilfered from their mines.

A pound of useful mica may fetch a price which is equal to a coolie's weekly pay. Any quantity of mica commands a ready

sale in the nearest bazars, and it is not possible to control the mica coolies who get low wages.

Quality and Uses of Mica.

Mica, on account of the combination of a variety of characteristics, is specially valued in many industries. Its chief characteristics are transparency, flexibility, toughness, perfect smoothness of surface, easy of being split into thin films, ability to stand heat; it is a good non-conductor of electricity, and this is why it is so extensively used as an Electric Insulator. Mica is used in stoves, compasses, in battleships for windows in turrets, incandescent lamp chimneys, diaphragms of phonographs and telephones, covers for boilers, and for aeroplanes. Mica owners, in classifying their mica for the market, depend on the following qualities which are essential for a first class mica :—

1. The colour should be pure ruby; white and black mica are not so valuable. Green mica of Madras does not occur here.
2. Mica should be free from any stain, cracks, water or air bubbles and black spots, and it should be perfectly transparent.
3. Mica should not be cross-grained, or pressure-marked known as "Jata."
4. The size of the pieces should be as big as possible; the bigger the mica, the greater the value.

Dressing of Mica.

Rough mica, when brought to the factory, is given to the cutters who cut off the rough edges with sickle-shaped knives. It is cut by holding it against a peg firmly driven into the ground, and the knife is used at an angle drawing it towards the cutter. He draws his knife in all directions, cutting off cross-grained and other defective portions. Pieces of mica stained, or with black spots which cannot be cleared by slicing off the upper films, simply have their edges trimmed, and will, of course, fetch a low price. As the cutter is compelled to use his knife as stated above, the dressed mica assumes all sorts of shapes.

Sorting.

Dressed mica is then sorted according to the following sizes :—

Extra Special	... 64 Square inches and upwards in area.				
Special	... 48	"	"	to 63⅞ square inches.	
Special A-1	... 36	"	"	to 47⅞	" "
No. 1	... 24	"	"	to 35⅞	" "
No. 2	... 16	"	"	to 23⅞	" "
No. 3	... 10	"	"	to 15⅞	"
No. 4	... 6	"	"	to 9⅞	" "
No. 5	... 3	"	"	to 5⅞	" "
No. 6	... 1	"	"	to 2⅞	" "

In sorting mica, the sorters use metallic plates of different rectangular measurements, for each of the above-mentioned grades. Practice has made them so expert in their work that they can sort mica according to size, without the help of these plates; whenever they are in doubt, they make use of the plates and satisfy themselves. It is obvious that a slight mistake, on the part of the sorters, leads to wrong classification and may thereby cause great loss to the mica owner, as the price of larger mica is high. These sorters receive a high wage, varying from Rs. 15 to Rs. 40 a month according to their skill. The sorted mica is again classified according to quality as follows :—

(1) clear, (2) slightly stained, (3) stained, etc.

Splitting.

Small mica, *i.e.*, Nos. 5 and 6, particularly the latter, is generally split into thin uniform films of $\frac{1}{1000}$ to $\frac{1}{1400}$ part of an inch in thickness at the splitting factories. These films cannot be gauged by eye, and an instrument, called the Micrometer, is used for this purpose. Good splittings will be very soft and smooth to the touch, and will be snow-white. The work of splitting is done entirely by women and children, with the help of a tapering knife or the thumb nail. A good worker can make about 2 pounds of splittings in a day, for which annas 2 to annas 3 a pound is paid. These splittings are used in manufacturing *Micanites*, which are used as a substitute for big pieces of mica. Micanite is a card-board like sheet made by pasting these splittings by heat, pressure and some chemicals.

Market and Price of Mica.

London is the market for most of the Indian mica. The sale is held by the brokers; Mr. Davis and Messrs. Baker and Startin of London are said to be the biggest mica brokers in England. Some of the biggest mica purchasers of India used to secure orders from Germany and America, and they sold their mica direct to those countries. This was the procedure before the European war broke out. They get their stock by extensive local purchases; though they have got no direct mining under their command, they export a large quantity of the mineral every year. A few of the mica mining companies of Kodarma send their mica direct to London. Other companies sell their production to the local purchasers who carry on the shipment. Before mica comes into the hands of these shippers, it is bought and sold several times by the petty purchasers and sellers. It is needless to say that the actual shippers get about 50 to 100 per cent. better price than the local sellers. All Indian mica is "muscovite," and the ruby mica of Hazaribagh is said to be the best in the world. About 39,000 cwt. of mica valued at about £170,000 is said to be the average yearly production in India, and more than half of this is supplied from the mica fields of Hazaribagh, Gaya and Monghyr districts.

The market price of mica fluctuates considerably: according to the London lists of 1914, the prices for Ruby mica per lb. were as follows:—

		Clear.	Slightly stained.	Stained.
Extra Special	...	20*s.*	14*s.*	9*s.*
Special	...	15*s.*	10*s.* 6*d.*	8*s.*
Special A-1	...	10*s.* 6*d.*	9*s.*	7*s.*
No. 1	...	9*s.* 6*d.*	8*s.*	6*s.* 6*d.*
No. 2	...	9*s.*	7*s.* 3*d.*	5*s.* 9*d.*
No. 3	...	7*s.* 3*d.*	5*s.* 9*d.*	3*s.* 6*d.*
No. 4	...	5*s.*	3*s.* 6*d.*	2*s.* 6*d.*
No. 5	...	2*s.* 10*d.*	2*s.*	6*d.*

On account of the European war, the shipment of mica has almost stopped, and most of the companies have reduced their staff and are working on a reduced scale.

A PLEA FOR MORE RATIONAL USE OF JUNIOR GAZETTED OFFICERS.

In Burma we say we are under-staffed, yet some senior officers still insist on employing highly trained officers on works which can be carried out just as efficiently by subordinates. This applies more especially to girdling. Some relaxation of the rule that *girdling must be done by gazetted officers has, it is true, been* allowed by giving gazetted officers charge of two or three girdling parties, but only on the strict condition that a very large percentage of the number of trees girdled must be inspected, or that each girdling officer is accompanied every second or third day by the gazetted officer. A recent instance of the lengths to which this absurd procedure is carried may be given. The gazetted officer in charge of three girdling parties was transferred when only a week's girdling remained to be done. The girdling officers under him were three Deputy Rangers, two of whom had been trained at the Pyinmana Forest School, and the third had had considerable experience of back hammer work and had been girdling under supervision for some little time. The gazetted officer applied for permission for the girdling officers to complete the work by themselves. This was only allowed on the condition that on no account were the subordinates to do more than 2 days' girdling without supervision! And yet we grumble about lack of staff. Apart from the question that a more rational use of subordinates might permit of more of the junior officers being released for the Indian Army Reserve, surely more use can be made of highly trained men than to tie them down to supervise an operation that is largely mechanical. Girdling can be, and in many cases has been, very efficiently carried out by untrained selected subordinates, not to mention those who have benefited by the thorough training now given at the Pyinmana Forest School. Yet, in Burma, we constantly see Deputy Conservators of Forests of 7 to 8 years' service being employed on girdling, and even then it is considered necessary for the Divisional Forest Officer to waste time inspecting their work! Of the 20 Imperial officers of 8 years' service and under on duty in Burma during the last season, no less than 10 were on

girdling duty, 6 were in charge of Divisions, and 4, of whom 3 were Timber Assistants, were on other duty. On the other hand, how many gazetted officers have more than a superficial knowledge of improvement fellings? Indeed, how many Divisions in Burma can be said to be doing more than paying at improvement fellings? The usual excuse is lack of staff. Surely it would be more useful to employ gazetted officers in supervising and training subordinates in improvement works than in doing girdling.

For the first year or two after joining, it is admittedly a good thing to employ officers in girdling or doing the actual improvement felling. This is good training and the officer is able to pick up experience of the work at first hand. After that an assistant is of far more use to his Divisional Forest Officer if he is given the supervision of important works. Admittedly, girdling is one of the works that should be inspected frequently, but there are many other works of equal or even greater importance which are at present indifferently supervised or not done at all, because the assistant is tied down to girdling. Moreover, surely some of the assistants now employed, year after year, on girdling would be more usefully employed on drawing up working-plans, which are at present at a standstill owing to the supposed lack of staff, we are certainly under-staffed but can hardly make out much of a case until we employ what staff we have in a more rational manner.

NGADAUK.

NOTES FROM DEHRA DUN.

HERBARIUM.

I.

BY R. S. HOLE, I.F.S., FOREST BOTANIST.

Among the specimens recently sent to Dehra Dun for identification are two plants of unusual interest. The first of these is *Calophyllum cuneifolium*, Thwaites, collected by Mr. H. Tireman, Deputy Conservator of Forests, at 4,500 feet in the Ghat forests of Coorg, where it is known under the vernacular name of *poon*. Hitherto, this tree has been reported only from Ceylon where it

is said to be "very rare." (Trimen's Fl. of Ceylon, I. 103). The other is *Toddalia bilocularis*, W. & A., for which we have to thank Mr. T. R. D. Bell, Conservator of Forests, Bombay. Regarding this tree Talbot in his Forest Flora I. 190 (1909), says,:—

"A very rare species in the Bombay Presidency and has only been found hitherto by Dalzell in the N. Kanara district." Mr. Bell states that the tree generally grows near water or in damp places and that it is common at Gersoppa and Jog in the Honawar Taluka of Kanara. A point which has given rise to some confusion regarding this tree is the statement in the *Flora of British India* I. 497, "leaflets 6—10." The leaflets are never more than three in number, and from the context there is little doubt that this statement should read "leaflets 6—10 in.", *i.e.*, the leaflets are 6—10 inches long.

BALSA WOOD.

BY R. S. HOLE, I.F.S., FOREST BOTANIST.

The author of the note on Balsa wood in *Indian Engineering* which was also published in the *Indian Forester*, Vol. XLIII, p. 241, asks for information as to whether this timber does grow in India and, if so, where and to what extent.

The extraordinarily lightwood commonly known as Balsa is yielded by the species *Ochroma Lagopus*, Sw., which belongs to the *Malvaceæ* and is sometimes called the Cork tree of the West Indies. It grows in Jamaica, Trinidad, Cuba, Guadaloupe, Mexico, Venezuela and probably fairly generally in the West Indies and tropical America. Hitherto this tree does not appear to have been introduced into India, but the writer hopes soon to obtain a supply of seed for experimental cultivation.

EXTRACTS.

KILLED IN ACTIVE SERVICE.

A military department notification by the Lieutenant-Governor of Burma says: "The undermentioned officers, occupants of civil posts under the Government of Burma, have been killed in action or have died of wounds received in action, during the first three years of the war:— . . . . George Reginald Jeffery, Imperial Forest Service, killed in action; . . . . Edward Vezian Ellis, Imperial Forest Service, died of wounds; George Henry Alington, Imperial Forest Service, killed in action. . . . . . . This notification is published in honour of the memory of gallant officers who gave their lives for their country."—[*Rangoon Gazette.*]

BURMA OFFICER GETS MILITARY CROSS.

A correspondent informs us that Mr. S. F. Hopwood (Deputy Conservator of Forests, Burma, whose services were placed at the disposal of the War Office), writing from the West front on the 31st May, says that he has been out in France since the beginning of July 1915 with one of the old regular field batteries and that he was right through the battle of the Somme, and as he is in a *corps d'élite* he is in every big offensive. At the time he wrote he was living in an old chateau which must have been a glorious place before the war, lovely grounds with fine trees and gardens, now all weeds and shell holes. There are hardly any of the bricks of the chateau left above ground. Most of the officers sleep in a deep ice chamber, but Hopwood and another officer sleep in the sewer! which rocks like anything when the big shells come over it. Our correspondent informs us that Mr. Hopwood has won the Military Cross.—[*Rangoon Gazette.*]

CREOSOTED LUMBER *vs.* SUBSTITUTES.

Every thoughtful student seeking to increase the scope of wood is confronted with the fact that its weakest and most vulnerable point is its susceptibility to decay when brought into immediate contact with the earth. This point is emphasized in the case of the railroad tie. Experience has proved, however, that with the application of proper creosote treatment, the life of an ordinary Douglas fir tie can be doubled and even trebled. The difficulties surrounding the older systems of creosoting was evidenced in the great weakening of the timber, due to the pressure which was exerted to force the creosote into the wood. Demonstrations showed a deterioration in natural strength as high as 36 per cent. in some cases. Experience demonstrated that the shallow perforation of the tie at intervals over the entire surface area, permitted a uniform penetration to a considerable depth, the creosote following along between the layers of summer and winter growth. By this system excellent results are obtainable with a modicum of loss of

strength. One railroad, for instance, had practically abandoned the use of Douglas fir ties, due to the weakening of the fibre of the wood through former creosoting processes. The excellent results now attained by the perforation process will exercise a strong tendency to bring this railroad again into the market, as a purchaser of treated Douglas fir ties. This company has experimented with Japanese oak ties, which signally failed. Australian, Hawaiian and other woods gave fair results. Good service was obtained from Port Orford cedar, but the available quantity of this latter wood is limited. Here is a striking example of the necessity *for the fir lumber industry to increase the use value of the product* if it hopes to successfully compete with other material. Creosoting or some equally effective means of preservation is the solution.

In the matter of material to be used for bridges and other permanent improvements, where the span of service must cover at least 20 years, creosoted lumber offers the only real competition with cement or steel. Untreated lumber will not insure sufficient life for the structure to give it a chance in a competitive race. There is a large and growing field for the use of lumber in country bridge construction. Ornate plans have been prepared for the erection of wooden bridges both of the open and covered type, constructed from creosoted material which, if pushed with the same degree of intelligence and persistency as steel and concrete, would command a fair share of the business.

We have reached an age when the architect and engineer prescribes the standard qualifications of building materials. His judgment is final. The lumbermen have the battle against substitutes largely in their own hands and a liberal use of creosote will help, win and maintain a place for lumber which otherwise will inevitably be filled with concrete and steel. Too much stress cannot be laid on this subject. Now is the time to hit, and hit hard.—[*The Timberman.*]

THE FEEDING VALUE OF WOOD.

Some suggestive experiments have been recently carried out in Germany by G. Haberlandt, partly under official auspices, on the possibility of utilizing wood as food for animals and man. The first experiments were made on a sheep, in a respiration chamber, for the purpose of determining the digestibility and nutritive value of birch wood. The trees were felled in the early spring, and the trunks, measuring 4 to 6 inches in diameter, were reduced to very small chips in a paper-mill. Microscopic examination showed that the wood was very finely divided, so that the membranes of nearly all the cells were destroyed, while the cell contents had been almost all removed by water used in the preparation of the wood. Thus the residue consisted chiefly of cellular membrane. The wood was fed in combination with other foods. Good results were obtained both as to digestibility and nutritive value. Apparently, the reason why previous experiments on the same subject had not been successful was that the wood was not cut up fine enough and its cells were not thoroughly torn. The experiments were repeated by Prof. Rubner on a dog, the same wood ration being fed with meat, and the results were also successful. Haberlandt believes that man is capable of digesting finely ground birch wood, and that it might replace rye or wheat to the extent of 10 or 15 per cent. in bread-making.—[*Scientific American.*]

WOODS CALLED "MAHOGANY."

A bulletin just published by the Department of Agriculture on the subject of Mahogany records, among other interesting facts, the bewildering ambiguity of the term "mahogany." True Mahogany is produced only by two closely related species of tree, *Swietenia Mahogani*, Jacq., and *Swietenia macrophylla*, King, both natives of tropical America. The name "mahogany" with or without some qualifying word such as "Indian," "Madeira," "African," "Philippine," etc., is, however, applied to cabinet woods grown in a great many parts of the world. These so-called mahoganies belong to 67 distinct species, of 41 genera, and they are

scattered through 18 families of the vegetable kingdom. Of some of the West African species the botanical status is unknown. To add to the confusion, true Mahogany has many names, and several more or less distinct varieties are recognized commercially.—[*Scientific American.*]

AFFORESTATION IN SCOTLAND.

Various schemes for the promotion of afforestation in Scotland, by co-operation between the land-owners and the State, are discussed in three articles in Transactions Roy. Scottish Arboricultural Society, XXXI, part i (January, 1917). The Development Commissioners, who have lately forwarded their proposals for afforestation and land reclamation to the Reconstruction Committee, do not favour the purchase of land by the Government but recommend that it should be taken on lease, the land-owner to receive, in addition to a rent, a bonus or percentage on the profits of the undertaking. Mr. S. Gammell advocates a scheme of planting by the land-owner, who would receive from the State a loan for this purpose, to be repaid, after the lapse of a period of forty years, in twenty annual instalments, calculated on compound interest at 2½ per cent.—[*Nature.*]

FORESTS AND RAINFALL.

I.

The note drawn up by Mr. M. Hill, F.L.S., C.I.E., Chief Conservator of Forests, Central Provinces, which is based on an enquiry into the relation between forests and atmospheric and soil moisture in India, is one that comes on us with some surprise. We were not aware that the Government of India had undertaken an enquiry on such a scale, and now that we have seen the note on it, we congratulate Government on the thoroughness with which it has investigated so interesting a subject, one also on which so many vague and conflicting opinions have been held. These very questions have, for some years past, been concerning the

United States Government, and our own columns have, from time to time, briefly referred to the studies made by the scientists of that country which, we may say, generally have not in all cases been confirmed by the enquiry now completed in India. The *Indian Forester* of July 1911 had a note on the general question to which we ourselves referred in our issue of 12th August 1911; but when that note was written its conclusions were considered premature and inconclusive and we were promised a further enquiry. We are, however, glad to find that this further enquiry confirms some of the conclusions already reached six years ago. As regards opinion in the United States, we find on turning to our own pages in the issue of 14th October 1911, that the Weather Bureau of that country at that time held "that forests have no effect either upon the amount of rainfall or upon the severity of floods; that ploughed fields will hold water quite as well as the ordinary humus of the forest, and that it is believed no case can be shown where deforestation has augmented droughts and floods." This opinion was vigorously challenged in the *Indian Forester* and, as if to drive home the Indian view, we were able to publish in our number of 12th December 1914, a short note on "Forests, Stream-flow and Rainfall" giving the case of an experience in Idaho, U. S., where a forest fire, four or five years before, had burnt out the catchment area supplying water to the city of Wallace, both for its water-supply and to operate an electric plant. After the fire, though the rainfall continued normal, the flow of the stream became irregular, the minimum fell to 25 per cent. below the former minimun and the electric plant at times could not be worked. The authorities consequently undertook to re-afforest the catchment.

The enquiry here dealt with had been made province by province throughout India and Burma at the request of the Government of India, and was as comprehensive as possible subject to available data, and the note as stated is based on the results of the enquiry. Moreover, as the percentages of forest land and the rainfall in the various provinces differ materially, we have results afforded by as varying conditions as it was possible to assemble. In the first place, one very common illusion may be taken to be

dispelled; and this is that there have been noticeable climatic changes in India in recent years. Rainfall to-day is much the same as it was fifty years ago; it is far from constant in any province from year to year; on the contrary, there may be progressive increases or progressive decreases over a succession of years, but these are not maintained and averages taken over long periods remain practically constant. The rainfall in India, as a whole, depends on factors outside the country and is affected within the country by local conditions; the effect of forests is small, Dr. Gilbert Walker puts it at 5 per cent. at the outside, and it remains doubtful if areas outside the forest are affected at all. It is possible (but this is entirely our own view) that any increase of precipitation within a forest is taken from the region surrounding it and that neighbouring rainfall may be less by just so much. An enquiry into whether there had been any permanent alterations of the water-table led to the conclusion that no reliable evidence could be adduced showing that such had been the case, and that it appeared to fluctuate everywhere with the rainfall. The next point on which a conclusion was come to was that, on the whole, it could not be said that the flow of rivers and streams was less equable, that floods were shorter in duration and more violent, and that streams dried up more quickly. But more important than this general conclusion was the one respecting the bearing on such effects of the destruction of forest vegetation in the catchment areas of individual rivers and streams. On this point, as it is one of special importance, we quote the words of the note—"Generally then the conclusion to be formed as regards this question followed that of the preceding one, that in most provinces no serious damage to the flow of rivers had taken place and no great injury had been done to cultivation. There were, however, several local exceptions and much damage had been done in the Punjab, in Bengal, and to a less extent in Eastern Bengal and Assam. Where damage was acknowledged it was on the whole admitted that this was due to forest denudation." There is enough, we think, in this paragraph to justify a practical acceptance of the fact that the removal of forest on an appreciable scale over a catchment

area, injuriously affects stream flow. It is true that the enquiry failed to elicit conclusive evidence to this effect in a great many cases ; but there are many reasons why, though palpable evidence was wanting, the fact should not be accepted. For example, the enquiry extended back to only 50 years or so, hence if denudation had been very gradual its effects would have gone back to a period long antecedent to the period investigated, the effects within the 50 years alone would not be very marked, and the evidence of deterioration would be small and uncertain. A case in which there had been wholesale denudation in a short time would present cause and effect more graphically and would be more valuable as evidence. Unfortunately the enquiry does not give us periods during which denudation has proceeded and we are, therefore, unable to weigh the evidence for and against deterioration with certainty ; we are disposed, however, to attach much importance to the following paragraph:—" In the Punjab it was admitted that the damage which had been caused in the Pabbi Range, in the Hoshiarpur Chos in particular, and in the Siwaliks generally, in the Lower Himalayas, and the Salt Range was due to the denudation of forest growth." There is quite enough evidence, on the whole, both in and out of India to justify the conclusion that forest denudation is highly injurious to regulated stream flow, and we trust that without further waiting we in India will make this a cardinal principle of forest administration.—[*Indian Engineering.*]

[We are unable to accept as probable the suggestion of *Indian Engineering* that " any increase of precipitation within a forest is taken from the region surrounding it and that neighbouring rainfall may be less by just so much." It is well known—and only natural—that the layer of air immediately above a forest area is both damper and cooler than the layer over the surrounding country owing to the water given off in transpiration by the forest leaf surface. We think it, therefore, probable that any excess rainfall which falls on the forest area is merely the re-precipitation of a portion of the water lost by evaporation from the trees in the forest and that it is unlikely that the rainfall on the surrounding country would be reduced thereby.—HON. ED.]

FORESTS AND RAINFALL.

II.

The note contains ample, even startling, evidence that forest denudation is even at this day proceeding at a most destructive rate. Of Chota Nagpur, perhaps the fairest district on this side of India, it is said—" It might be taken as certain that in the absence of any definite policy of conservation, Chota Nagpur and many parts of Orissa would, to the irreparable ruin of their prosperity, at no distant date be stripped of all growth except worthless shrubs." Of the Southern Shan States, and of the Myelat Plateau in particular, it is stated that in pursuance of the practice of shifting cultivation the pine and oak forests have been cleared with the result that nine-tenths of the plateau now consisted of bare open downs covered with short grass and bracken fern.

" As a consequence the water-supply had become scarce and the soil no longer had the power to hold large supplies of moisture and so to regulate the flow of water in the streams. During the rainy season the latter were subject to very sudden and violent floods which subsided as quickly as they rose and the water flowed either into the large Jule Lake or down to the plains of Burma, leaving the beds of the streams almost dry. The country was also cut up, as a result of these violent floods, by very deep ravines, having vertical banks, similar to the canôns found in the arid parts of North America. The soil on the plateau was a marvellously rich one and with a good water-supply the value and extent of the crops would increase tenfold." What then is the remedy for this state of things, and is Government setting itself seriously to the task of applying the remedy or remedies? It will be observed that the most serious destruction of forests takes place among the more or less wild tribes of the country and is due to the practice of shifting cultivation known variously as *taungya* in Burma, *kumri* in Assam, *jhuming* in the North-Western Provinces and *dhaiya* in the Central Provinces. In reserved forests, a system of more or less perfect preservation exists; in protected forests, there are less stringent rules but a certain amount of restrictive legislation goes far towards their preservation; in unclassed forests the

greatest mischief is done. But it must be recorded that from year to year land is passing upwards from one class to the other and in time all the forests may come to be reserved. Meanwhile, great difficulty is experienced in dealing with the habits of the wild forest tribes as their practices have come down from early times and shifting cultivation is in many cases their only means of subsistence at present. The question, however, is not being neglected and in the United Provinces in particular is now being effectually handled. Special legislation has in such cases to be enacted and strong repressive measures adopted; this is being extended in many directions and is bearing good fruit. The methods of forest management are even being extended to Native States by means of the loan of British Forest Officers. There is, however, a great deal of ground to be covered and considerable time must elapse before all is done that can be done.

It may now be said to be established that apart from their intrinsic uses forests have an influence generally beneficial to a country. They increase the rainfall to a small extent, say up to 5 per cent., they keep down temperature by about 2 per cent., both air and ground being cooler by this amount, and they keep humidity higher by about 10 per cent. They hold up rain and tend to equalize the flow of streams, thus mitigating floods and erosion and by so doing help to maintain the water-table at a higher level on the average. Their careful maintenance where they exist in sufficient area and their extension when they are deficient is thus a duty of the State, and this aspect of forestry places the responsibilities of a Forest Department on a higher plane than that of a mere grower of timber and seller thereof. It emphasizes the necessity of re-afforestation wherever possible and raises the question whether in the boundless plains of India given up to cultivation something might not be done in the line of village or other local forestry. Why, for instance, may we not utilize our roads and railways to better purpose? In taking up land for them we might always take up a wider strip than has been usual and use the temporary lands on both sides for plantations; this would intersect the plains in every direction with strips of

forest which besides helping in a measure the work of water regulation would be a boon to the villagers and their cattle.—[*Indian Engineering*.]

INDIAN FORESTRY.

From papers appearing in the issues of March and April of the *Indian Forester* we see that the department is becoming very much alive to the necessity for commercial forestry. Nor need we be surprised at its attitude. The subject has been discussed desultorily for some years now, but has made little impression ; but now that any forester who cares to look ahead can see that there must soon come a real boom in the timber trade he must feel that the time is opportune to press the policy on the Indian Government. A vast number of ships have gone to the bottom of the sea, we do not yet perhaps realise how many more are to follow, and we have already embarked on a policy of frantic ship-building to replace losses. It is true that we build steel ships not timber ones in these days, but even steel ships need a great deal of timber in their construction and the price of timber of every description has risen enormously and must remain high for many years. There must, consequently, be for many years a sustained demand for ship-building timber of every description, of teak in particular, which has become a favourite timber in the European ship-building trade. Had the Forest Department of the Government of India been already organized so as to meet the coming demand there would have been large profits in store for it ; but it is not too late yet to gird to because the demand is going to last some years and it is extremely improbable that prices will ever fall to their old level. Moreover, if the experiment to place on the seas at once a number of wooden ships of small tonnage should prove a success, we cannot tell to what proportions the demand for timber may grow, and perhaps the suggestion already made to turn out such ships in India itself may materialise. Looked at in any way, the question may be taken as settled that there must soon be a greatly increased demand for timber in all parts of the world—for restorations,

for a mercantile marine, for railways, and it will be a piece of commercial folly for India to sit with folded hands while the demand is being met by others. To go no further than India itself and the countries that may be said to come under its "sphere of influence," shall we not need immediate future large supplies of sleepers to catch up the standard of maintenance of our railways which we have allowed to lapse on account of war exigencies? Outside India are we not making ourselves responsible for building in the near future railways in Mesopotamia, in Persia, even in Egypt? The sleepers and other timber for such railways should naturally come from India, and they will, if time be taken by the forelock and the commercial exploitation of our forests, be at once put in hand.

But this cannot be effected under the old sleepy policy of meeting forest expenditure from forest revenue alone. The bolder policy must be adopted of raising forest loans, of employing forest engineers, of creating a large forest selling department, of delivering forest produce at marts where they will be taken over by dealers. On our railways we sell transportation, we do not tell the people—here are engines and carriages, there is a road, take them and carry yourselves and your goods to wherever you like. If we did this they would use neither, they would go in their old way in bullock carts along field tracks at two miles an hour. On the contrary, we run for them an up-to-date method of transportation and make them pay for it, whereby they profit and so do we. Likewise on our canals we sell water. We do not build head-works on a river and cut a channel and then tell the people—here is water in a river, and a gate to tap it by, and a channel to lead it, go and help yourselves. If we did this they would ignore our canals and adhere to their primeval water lifts. On the contrary, we deliver the water to them where it is wanted by the most scientific of methods and when they pay for it they find it is also the cheapest of methods; and we?—we make large percentages out of the enterprise. But neither railways nor canals are built out of revenue. Capital is raised to provide them, and similarly if capital is raised to provide transport for the timber and other forest produce from inaccessible

places to marts where they can be sold, transportation can be made to pay on the capital as well as cost less than any form of unscientific carriage. Is not this better than to let valuable forest products lie and rot because they are in places difficult to get at ?

A contributor to the *Indian Forester* of 17th March writes :— " Departmental extraction is still considered as a side-show of forest work in Burma. It seems that the extraction, transport and measurement of some 20,000 to 30,000 logs per annum can easily be sandwiched in between, and is indistinguishable from, the carrying out of the various sylvicultural works and the control of general revenue." Again, " there are various solutions to the problem, but all require that there shall be capital to put into the business by Government, and that Government shall take ordinary commercial risks." And, in conclusion, " the time is getting ripe for the separation of the purely commercial side of forestry in Burma from the administrative and preservative sides. To do this, the finance of the commercial side requires to be made commercial instead of statistical, and the staff for the commercial work needs to be made expert and to be ruled by commercial principles. A quasi-commercial enterprise is neither fish, flesh, fowl nor good red herring." Mr. E. A. Smythies, writing in the *Indian Forester* of April 1917, points out the anomalous position of Indian coniferous forests in the Himalayas where, although there are well over a million acres of such forests directly under the department, they are so little exploited as to leave India largely dependent on imports of coniferous timber from Europe and America. War conditions have, as a consequence, placed India in considerable difficulties since imports have fallen from 16,856 tons in 1912-13 to 5,672 tons in 1914-15, while average prices have risen in the same period from Re. 1-3-3 to Re. 1-10-3 per cubic foot. Minor forest produce again, such as resin and turpentine, though now put on a safe commercial footing is not being extracted to any but an insignificant extent. Why ?—because no efforts are made to make the forests reasonably accessible. Mr. Smythies goes on to say— " in the first place we require capital, and plenty of it. Capital for

saw-mills, capital for new and improved distilleries, capital for improving the means of extraction, *e.g.*, timber slides or ropeways, improving waterways (by dynamiting rocks), motor lorries on cart-roads, and similar measures; capital for initial outlay and development of new business, carrying stocks, and the like........... The opportunity to develop these industries is with us *now* while imported competition is at prohibitive prices, and we have here an exceptional case for a forest loan." To these measures must, of course, be added a considerable increase to the forest staff on the commercial side, there being no sense in employing trained forest officers to do this class of work. For forest officers there is a vast amount of other important work to do in the future. There are bare hill-sides or hills growing useless timber which can be made to produce valuable coniferous timber if planted out and conserved. Experiments in this direction have been successfully made on a small scale, they need to be made in fresh localities and where successful to be followed up by extensive planting. Such work cannot be undertaken by the present staff and when undertaken will add enormously to the potential wealth of the forests.—[*Indian Engineering.*]

VOLUME XLIII NUMBER 10

INDIAN FORESTER

OCTOBER, 1917.

CAUSE OF THE SPIKE DISEASE OF SANDAL (*SANTALUM ALBUM*).

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Procedure followed in study of Spike.

1. When investigating an unknown disease of a forest tree, the following appears to be the best general procedure :—

(1) to study as extensively as possible the conditions under which the disease occurs in the forest ;

(2) to formulate a theory based on this study as to the cause of the disease which is in accordance with the facts ascertained under (1) ;

(3) to obtain by actual experiment the proof, or the reverse, of the theory advanced.

The writer has now studied spike in the forests of Coorg during two tours at different seasons of the year and has also tested the effect of various factors on the growth of Sandal in the Experimental Garden at Dehra Dun. He accordingly now ventures to put forward a theory as detailed below which

appears to be in thorough accordance with the facts hitherto ascertained, to ask for a patient consideration of this theory and to request the co-operation of forest officers in the Sandal areas in obtaining the experimental proof, or otherwise, of the theory.

Cause of Spike.

2. It is believed that the pathological condition known as Spike is induced by an *unbalanced circulation of sap* which may be caused by a number of different factors.

Balanced circulation of sap.

In the case of a tree in which sufficient water (crude sap) is ascending the stem to provide for (1) the manufacture of carbohydrates and (2) the removal of the latter in the form of soluble sugars (elaborated sap) and for their utilization in the processes of growth, the tree is healthy and the sap-circulation may be said to be *balanced.*

Suspended sap-circulation.

In the case of a tree in which the water-supply is insufficient to provide for transpiration and carbohydrate assimilation, if the circulation cannot be sufficiently stopped by shedding the leaves or other protective devices, the tree must either die or suffer from the death of the twigs and leaves from drought, thus becoming more or less "stag-headed." In this case the sap-circulation, temporarily at any rate, is practically *suspended.*

Unbalanced sap-circulation.

Finally, if the water-supply is gradually reduced below that which is required for a balanced circulation, the sap-circulation becomes *unbalanced,* and an accumulation of carbohydrates such as starch in the leaves and twigs will result* thus gradually cutting off the food supply

* (1) B. L. Hartwell (*Starch Congestion* in Bull. 165 of Agri. Exp. Sta. of Rhode Island State College, Kingston, 1916, p. 21,) shows that a retardation in the rate of growth, due apparently to any cause, is accompanied by an increase in the proportion of starch in the above-ground part of certain plants at least.

(2) W. Pfeffer (*Plant Physiology,* Eng. Ed., by A. J. Ewart, Vol. II, p. 118, Oxford, 1903,) notes that "growth is very closely dependent upon the supply of water, for even a slight fall of turgor causes it to be distinctly slowed."

(3) W. L. Howard (*Study of Rest Period* in Missouri Agri. Exp. Sta. Bull. No. 21, Missouri, 1915, pp. 52, 53,) considers that, in woody plants, an imperfect sap-circulation and a decreased water-supply may lead to an increased deposition of carbohydrates.

necessary for the health of the roots. If this last condition is sufficiently prolonged it is believed that it will cause the disease known as Spike. An unbalanced sap-circulation may also be caused by any factor which retards growth without interfering with photosynthesis *e.g.*, a deficiency of an essential nutrient substance like phosphorus or which interferes with the translocation of organic food, *e.g.*, damage to the conducting tissue of the cortex.

Why Sandal and *Zizyphus Oenoplia* are especially liable to Spike.

3. The majority of trees do not appear to suffer from this last condition to any great extent, and the slight accumulations of carbohydrates which occur are usually dispersed in the so-called "rest periods" after which normal growth again sets in. The Sandal tree and *Zizyphus Oenoplia*, however, appear to be especially liable to this condition apparently for the following reasons :—

(1) Both species are extremely tenacious of life and are capable of continuing carbohydrate assimilation and slow growth under a condition of water-supply which, in other species, would induce death or "stag-head."

(2) Both species possess a thick, fleshy cortex which usually contains a considerable amount of moisture, and the latter often suffices to support, for a considerable time, the localized growth of twigs and the manufacture of carbohydrates, even when the main system of sap-circulation has been stopped. This can frequently be seen in the case of burnt trees in which the cortex, cambium and outer wood have been completely burnt at the base, and in which leafy twigs have subsequently been produced from the still living cortex above. Such twigs are frequently found to be spiked.

(3) Both species possess a remarkably strong and tenacious power of apical growth, and under a gradually decreasing water-supply the lower lateral twigs are often found to die off while the tips of the long branches still remain vigorous.

Probably owing partly to the smaller vigour of the laterals and to the fact that they are less well supplied

with water they are frequently found to suffer more from fire, suppression and insect attacks in both species than are the ends of the stems and branches. In both species, therefore, under certain unfavourable conditions of growth, we commonly find a continually increasing length of conducting tissue (which must be constantly renewed by a well nourished cambium if good sap-circulation is to be secured) without a proportionate increase in the area of the carbohydrate-producing green leaves and in the total amount of elaborated food necessary for the nourishment of the cambium. This results in an abnormally great length of poorly nourished cambium and slowly conducting tissues. A suddenly increased demand for water in such a poorly developed crown, such as would follow the removal of overhead or lateral shade, cannot quickly be met by the development of new rapidly conducting tissues for which a well nourished cambium with a plentiful supply of water and available food is necessary. The water-supply for the crown is consequently liable to be less than that required for a balanced circulation and a condition of Spike, stag-head or death is likely to ensue.

There is no doubt that, on the whole, the characteristics noted above are advantageous to the species in the struggle for existence. Both Sandal and *Zizyphus Oenoplia* are notoriously difficult to kill by mutilation while the strong power of apical growth and especially the capacity to continue slow growth when other species are obliged to suspend their growth give them a great advantage over other competing plants.

It is only under certain unfavourable circumstances that these characteristics seem liable to produce the pathological condition known as Spike.

Factors producing Spike.

4. From all the diseased plants hitherto examined by the writer of *Zizyphus Oenoplia* it appears that the unbalanced sap-circulation resulting in

Spike has been in every case caused by *fire*. In the numerous cases of spiked Sandal which have been examined this condition appears to have been brought about by the following four factors :—

(I) FIRE.

Fire damages the trees by killing the delicate aerial twigs and superficial rootlets as well as by more or less drying and damaging the fleshy cortex and cambium of the thicker superficial roots, aerial branches and stem. If sufficiently severe, fire kills the trees outright.

In cases where fire damages chiefly the twigs and branches *i.e.*, the upper portions of the tree, the result is usually a "stag-headed" condition and not Spike. In such cases the water-supply in the tissues of the stem, combined with that sent up by the uninjured roots, is sufficient for the healthy growth and nourishment of the comparatively short length of cambium and conducting tissues and for the vigorous development of the new adventitious shoots developed below the damaged portions of the crown. In such cases, therefore, there is no unbalanced circulation.

In other cases, in which fire damages chiefly the roots and lower portions of the stem and branches, Spike seems especially liable to result even when the damage is apparently not very severe. In such cases the lower lateral twigs are usually found to have been killed while the apices of the stem and long branches are comparatively healthy. Here, therefore, there is obviously a great length of cambium and conducting tissue, parts of which, also, have been more or less dried and damaged, or checked in growth by the fire. The rate of upward flow of water also tends to be diminished by damage to the roots of Sandal and of its hosts and by the reduced sucking force in the leaves owing to the destruction of the lateral branches and twigs.

The amount of water reaching the terminal twigs, therefore, in a unit of time is reduced, less water will be available for the translocation of the carbohydrates, while the latter process is also checked by the more or less severely damaged cortex in the lower portions

of the branches and stem. Under this condition of unbalanced circulation, according to the theory now advanced, carbohydrates would tend to accumulate, leading sooner or later to Spike.

It is probable that fire would produce this result more readily in stems which are already poorly nourished on account of partial suppression.

In cases of severe fire damage not sufficient to cause death, but in which the whole tree has been more or less completely burnt, the water ascending in the inner comparatively uninjured wood, together with that locally available in the tissues, is sometimes sufficient for the development of dormant and adventitious buds, but the translocation of carbohydrates appears to be too slow to allow of a balanced circulation, either on account of a deficiency of water or the severe local burning of the cortex and cambium below. In such cases Spike and not a "stag-headed" condition appears to be the usual result.

It is remarkable that several observers have noticed that fire appears to be able to produce the disease. Thus, in his account of the disease written in 1899, Mr. C. D. McCarthy gives instances of Spike which apparently originated as a direct result of fires and in which "cause and effect immediately succeed one another and are very apparent." Mr. P. M. Lushington also wrote in 1903, "I cannot help thinking that the disease will eventually be traced to fire."

(II) Death or Damage of Hosts.

The girdling, uprooting or other damage to hosts may reduce the water-supply to that which is only sufficient for an unbalanced circulation, while being insufficient to cause death or "stag-head."

(III) Partial Suppression by Lantana or other Growth.

This frequently appears to result in the gradual development of a length of cambium and conducting tissue disproportionately great to the small crown and supply of elaborated food. The cambium and conducting tissue becoming gradually starved results in a slowly decreasing sap-circulation which ultimately appears to cause Spike.

(IV) Exposure of Trees hitherto growing under Shade.

Such exposure frequently appears to result in an increased loss of water from the transpiring leaves while the roots are unable to proportionately increase the supply available, especially when only the roots of an unsatisfactory host such as lantana are available or the cambium has been poorly nourished owing to a more or less prolonged period of partial suppression.

All the cases of Spike in Sandal hitherto seen by the writer can, it is believed, be explained under the above four heads.

Lantana appears to be particularly injurious inasmuch as it greatly increases fire damage of the kind particularly liable to cause Spike, especially in dry localities, *viz.*, a low fire burning the soil and roots and scorching the bases of the stems and branches, while doing comparatively little injury to the apices of the stems and branches. It also tends to increase the damage done under heads III and IV above. Although Sandal haustoria readily penetrate the roots of lantana, these haustoria usually appear to decay quickly which is not the case with a good host like *Acacia Suma* for example. There seems to be little doubt that the enormous increase of Spike noticed in recent years in Coorg is chiefly due to the spread of lantana and the incidence of Spike in Coorg is worst in dry lantana areas which are frequently burnt.

Additional factors which may cause Spike.

5. From what has been said above it will be clear that Spike is ascribed to an unbalanced sap-circulation caused by a slowly decreasing water-supply or by any factor capable of retarding growth or of interfering with the translocation of organic food. Obviously therefore, if the present theory is correct, in addition to the four factors mentioned above, which, in the cases seen by the writer, appear clearly to have been the primary causes of the disease, the following will probably be found to be responsible in at least some cases :—

(1) *Drought* acting directly or indirectly through the hosts. Bark scorching by the sun may often accentuate this.

(2) *Bad soil-aeration* which may similarly act directly or indirectly through the hosts. A dense growth of lantana, grass or herbaceous plants, compacting a heavy soil, *e.g.*, by grazing, accumulations of humus and any factor which is likely to keep the soil constantly wet are all liable to produce this condition which is undoubtedly injurious to the roots of Sandal.

(3) *Damage by insects.*—Sucking insects which damage the cortex and interfere with the circulation of elaborated sap may in some cases produce the disease.

The general tendency of insects to attack plants, the health of which has already been impaired by other factors, must, however, be borne in mind.

Dr. Coleman's grafting results.

6. It may now be argued that the results of Dr. Coleman's grafting experiments clearly prove that Spike is an infectious disease due to a specific organism or virus and that, therefore, the present theory cannot be correct. It is possible, however, that these results may by explained otherwise than by assuming the existence of a virus or organism. An undue accumulation of organic food may cause a more or less prolonged weakening or inhibition of the action of enzymes.* If now a spiked twig packed full of starch is grafted on to a healthy plant, the active diastase in the tissues of the stock, acting on the starch in the adjoining cells of the scion, may produce locally a quantity of soluble sugars in excess of that which can be rapidly translocated and utilized for growth. Such an excess would tend to weaken the enzymatic activity and cause a deposition of starch in those cells of the stock into which the sugars had diffused. The starch thus removed from the spiked scion, also, might again be made good by the manufacture of additional starch in the leaves of the spiked scion. In this way a progressive weakening of enzymatic activity and extension of starch accumulation, sufficient to

* Both G. Klebs [*Ueber die Rhythmik in der Entwickelung der Pflanzen* in Bot. Centlb. 119 (1912), p. 426, and W. L. Howard (*Study of Rest Period* in Missouri Agri. Exp. Sta., Bull. No. 21, Missouri, 1915, pp. 49, 52, 53,) consider that an accumulation of organic food, such as carbohydrates, by checking and more or less inhibiting enzymatic activity, is the primary cause of the more or less prolonged "rest-periods" in plants.

cause the appearance of Spike, might take place in the tissues of the stock.

Apart from this explanation, also, it must be remembered that an unhealthy condition leading to the production of a virus in the tissues or rendering possible the attacks of an injurious organism may be primarily due to one or more of the factors which have been mentioned above as probably the primary causes of Spike.

Spike is apparently not really infectious.

7. Observations in the forest do show that the disease often extends from an infected tree or group of trees in a manner that suggests spread by infection. Assuming that one healthy Sandal tree designated A is connected by haustoria with the roots of another Sandal tree designated B. If the latter tree is killed by fire or any other factor, or is spiked, its roots will cease to supply A with water. This reduction in its water-supply may suffice to spike tree A and in this way the disease might gradually spread. It must also be remembered that one and the same factor, *e.g.*, the felling of a host, may spike the less vigorous Sandal, or those which are most dependent on the host more quickly than other more vigorous or less dependent trees. The latter spiking one or two years later than the former, but in their neighbourhood, would also produce the impression of a spread by infection.

That the disease is not really infectious is indicated by the frequent occurrence of isolated cases of Spike several miles from any infected trees and also by the fact that trees quite close to spiked individuals not infrequently remain free of Spike for long periods.

Why very sickly trees are often not spiked.

8. Extremely sickly and more or less "stag-headed" Sandal trees may frequently be seen in open exposed areas devoid of good hosts. Such plants frequently remain free of Spike. In such cases, however, the sap-circulation, although it may be very slow, may be *balanced;* the small amount of water taken up from the soil being sufficient for the translocation of the small amount of starch made in the attenuated crown which, in its turn, suffices for the nutrition of the small amount of living cambium in stem and roots.

Experiments necessary to prove the theory.

9. An experiment carried out by Mr. Tireman in Coorg has clearly indicated that, even in a fire-protected area, the uprooting of lantana has materially diminished the incidence of Spike, which, so far as it goes, clearly supports the present theory. The latter is, it is believed, also supported by, or at least is compatible with all the reliable experiments and observations which have as yet been placed on record regarding the disease. Further it is obvious that if the theory is correct conclusive proof regarding it can now easily and quickly be obtained by a few simple forest experiments of which the following appear to be at present most important :—

(I) In localities where there is as yet no Spike select two areas, as similar as possible in acreage, type of growth and number of Sandal trees, then burn one of these areas annually and protect the other. In this way it should be possible to produce Spike in areas where it is at present unknown. Dry localities, with a small rainfall or shallow stony soil, well stocked with lantana, are likely to give the best results.

(II) Select 50—100 Sandal trees, each one growing close to one or two large hosts, the latter being distinctly dominant with reference to the surrounding vegetation. In the case of one half of the selected Sandal trees these large hosts should then be felled and their stools dug out, while in the case of the remainder the hosts should be carefully protected from injury. Some at least of the Sandal, the principal hosts of which have been removed, should get Spike. In some experiments the hosts should be felled in August and in others in March. In the former case the effect is likely to be more gradual and conducive to Spike, in the latter case the action may be too sudden, resulting in some cases in death instead of Spike.

Hosts which readily produce root-suckers should not be selected.

(III) Seleet 50—100 Sandal trees which are suffering more or less from suppression and which have lanky stems and branches bearing very little foliage. Expose the crowns of these trees to free overhead and side-light by pollarding and cutting away the surrounding growth. One half of these Sandal trees should be pollarded at the same time as the surrounding growth is cleared, the other half should be left untouched. The incidence of Spike among the latter should be greater than among the former.

(IV) It is possible that the effect of gradual suppression might be reproduced by repeatedly pruning off all lateral twigs so soon as they appear, encouraging only apical growth of the stems and branches by allowing only one terminal twig to develop in each case.

(V) Mr. Tireman's experiment with uprooting lantana should be repeated in other localities.

(VI) In localities where there is as yet no Spike in *Zizyphus Oenoplia* but where this species is plentiful, select two areas, as similar as possible in acreage, type of growth and number of *Zizyphus* plants, then burn one of these areas annually and protect the other.

In this way it should be possible to produce spiked *Zizyphus* in areas where the disease does not at present exist. It is believed that careful experiments on these lines will furnish conclusive proof of the theory here advanced probably in one or two years.

Steps necessary to prevent Spike.

10. In anticipation of such proof, however, it may be said that the principal steps necessary to prevent Spike at present appear to be—

(I) *Fire-protection.*

(II) *Elimination of Lantana by uprooting.*

The eradication of lantana is cheaper and easier if it is first burnt. If, therefore, this is necessary the Sandal should be first coppiced or pollarded and if possible burning the lantana in the immediate neighbourhood of the trees should be avoided.

(III) *Careful Tending.*

This must aim at—

(*a*) *maintaining good host plants near the trees.* In the dry areas of Coorg, *Acacia Suma* appears to be a particularly good host. When lantana is removed, if there is a scarcity of good hosts, the latter should be established as quickly as possible near the Sandal trees. This can often be done more satisfactorily and quickly by transplanting fairly large plants, having first cut back their shoots and roots rather than by sowing ;

(*b*) *avoiding severe damage to host plants, e.g.*, by girdling or felling. If the injury to host plants is unavoidable, *e.g.*, when bamboos die naturally, the neighbouring Sandal trees should be pollarded or coppiced, and unless sufficient good hosts are available new hosts should be established near them as quickly a possible. A similar procedure should be followed in the neighbourhood of Sandal trees which have become spiked. This may enable the plants to make a new start with new host connections ;

(*c*) *providing for the free and natural expansion of the crown from early youth ;*

(*d*) *freeing very carefully and gradually those trees which have been more or less suppressed.* Such trees, however, will probably be less liable to Spike if they are pollarded or coppiced when they are set free ;

(*e*) *providing light side shade to avoid damage from drought and sun-scorch ;*

(*f*) *providing free overhead light*, or, in dry localities, a very light over-head shade, such as that furnished by *Acacia Suma ;*

(*g*) *not allowing a heavy growth of grass or herbaceous plants to develop near the trees.* Such plants are bad hosts, providing only a small and uncertain water-supply, and are apt to produce a badly aerated soil ;

(*h*) *avoiding compacting the surface of heavy soil, e.g.*, by grazing.

Additional measures to those enumerated above and which have been recommended in the past are—

(1) measures based primarily on the assumption that the disease may be communicated through the roots such as *isolating the infected trees by trenches and digging up and removing all spiked trees.* There is as yet no evidence to show that the disease can be communicated through the roots (otherwise than by affecting the water-supply of neighbouring plants) even by grafting and pending such proof the utility of such measures appears to be doubtful. Assuming the possibility of such infection, there is no certainty that the disease may not have been communicated before the trench is dug. The digging up of an infected tree also does not necessarily serve the connection between its roots and those of neighbouring trees. The writer has found a case in which a lateral root of a Sandal tree, which had been dug up at least one year previously, was still alive, apparently healthy and grafted to a neighbouring Sandal;

(2) *the formation of protective belts by removing all the Sandal trees over extensive areas.* This is not likely to materially check the spread of the disease and will involve the unnecessary destruction of healthy Sandal on a large scale.

Too much importance, also, must not be attached to isolated cases in which the clearing of such lines in the past may appear to have retarded the spread of the disease, as such lines may have been cleared in localities where, on account of other conditions, such as increased rainfall, less damage by fire, etc., the extension of the disease would, in any case, have been very slow.

11. In case the theory which is here advanced ultimately provides the solution of this important problem, it must be noted that its inception is very largely due to Mr. G. S. Hart, Inspector-General of Forests, and Mr. B. B. Osmaston,

President, Forest Research Institute, Dehra Dun, who have steadily encouraged and helped the writer in his work, to the kindness of Dr. L. C. Coleman who showed the writer his most interesting and important grafting experiments, to the accurate observations of Mr. C. D. McCarthy, to the information kindly supplied by Mr. P. M. Lushington, to the work and publications of Messrs. Barber, Butler and M. Rama Rao and especially to Mr. H. Tireman who has given the writer the greatest help in studying this disease in the forest and whose experiments and progressive tending work with Sandal have clearly indicated several of the most important factors which influence the well-being of Sandal in the forest.

12. Finally, it is possible that the explanation here given of Spike may be found to apply to other highly injurious and hitherto obscure diseases, such as Peach Yellows, and that factors checking the healthy circulation of sap, such as injudicious pruning, may be the primary cause of the trouble.

THE SAL FORESTS OF GORAKHPUR DIVISION.

BY R. G. MARRIOTT, I.F.S.

The Sal forests of Gorakhpur Division cover just over 64,000 acres in the Gorakhpur district. They consist of several isolated blocks surrounded by cultivation or grass-land, and are drained by small rivers and streams. Between the dry weather beds of the streams and the Sal forest there is almost invariably a strip of low-lying grass-land which is flooded after heavy rains and becomes for the time being part of the bed of the stream. In a few places, the Government reserves adjoin the remnants of private Sal forests which are gradually being destroyed by cultivators. Gorakhpur is, in most respects, a typical district of the upper Gangetic plain, a flat expanse of alluvial land. The northernmost Sal forest in the division is about ten miles south of the foot-hills of the Himalaya and the southernmost about sixty miles. About 90 per cent. of the trees in the Sal forests are Sal. In describing the forests it is necessary to distinguish two well-marked natural types which may for convenience be termed A-1 and A-2.

Type A-1 contains many straight well-grown Sal trees, a fair porportion of which may be expected to reach a girth of 6 feet without becoming unsound. It is seldom found at a distance of more than a mile from a stream or from the edge of the strips of low-lying grass-land on either side of the streams, over which the water flows after heavy rains, and, as a rule, it is only a narrow strip fringing the main part of the forest described below as A-2. It is sometimes characterised by a dense undergrowth of *Mallotus philippinensis*, *Croton oblongifolius* or *Ardisia humilis*. Natural regeneration of Sal is often scanty owing to the heavy canopy of the overwood or to the dense undergrowth of the above-mentioned miscellaneous species and others, but the soil is, as a rule, in perfect condition for seed regeneration and often responds to a sudden interruption of the canopy by producing a very good crop of Sal seedlings.

Type A-2 is inferior to A-1 in every respect. The trees are smaller, grow more slowly and are often very crooked. Most of the stems of over 4½ ft. at breast-height show signs of decay and, in some parts, the trees do not even reach this girth in a healthy condition. The soil varies very much as regards natural regeneration. Over areas of considerable extent the ground is well stocked with Sal seedlings and saplings, while in other parts, where the conditions at first sight seem to be exactly similar, there is a dense growth of grass. This type constitutes the whole forest with the exception of the very limited part comprised under type A-1.

It has been suggested that the poor growth of Sal in Gorakhpur division is attributable to the high sub-soil water-level * and to bad surface drainage. This, however, does not seem adequately to explain the fact that some of the best Sal forest of the good type is on very low ground, *i.e.*, in places where the

* The permanent cold weather water-level in Gorakhpur forest division is from 12½ ft. to 18½ ft. from the ground surface.

ground surface is nearer the sub-soil water-level and more often flooded during the rains than elsewhere, while some of the bad type is in situations which escape floods altogether except in years of unusually heavy rainfall. Although surface drainage undoubtedly has much to do with the excellent quality of the growing stock in the good type, the main cause of the difference between the two is probably bad aeration of the sub-soil.

Although the soil near the rivers and streams gets thoroughly soaked after every heavy downpour, yet the water in it, being near a strong current, is probably always in motion and therefore fresh. Fresh water contains air and is therefore beneficial as it oxidises injurious substances or carries them off in its flow. But when the flat expanses of country between the main natural lines of drainage become waterlogged the excess sub-soil water probably moves very slowly or becomes quite stagnant. The roots of the trees are consequently unable to obtain the quantity of oxygen that they require and may even be poisoned by an accumulation of carbon dioxide and other injurious substances. During the rains, therefore, the trees may practically cease to grow * which would partly account for the fact that the average girth of the stem in a forest of this type is sometimes 1 to 2½ feet less than in an adjoining forest of the same age near a river bank. Moreover, the waterlogging of the soil in the level tracts at a distance from the rivers is not always limited to the short periods when the country is flooded. When the floods subside after heavy rain the water-level sometimes appears to sink to the normal more quickly in the neighbourhood of rivers and streams than at a distance from them. A well was dug in the forest at about 2½ miles from the nearest stream during

* A point which requires investigation before it can be stated as a fact. Sample plots should be measured to determine whether the girth increment of trees slows down during the rains and if so, whether this is more marked in the one type of forest than in the other. The frequent flooding of the land near rivers is constantly enriching the soil with deposits of comparatively coarse-grained silt and, in such localities, the rapid subsidence of the water through the soil after each inundation probably sucks in fresh air and thereby ensures good soil-aeration. Trees growing in these localities, therefore, must develop an exceptionally good root-system and this would partly account for their quicker growth even if growth only took place during the same seasons as in the poor type of forest.

the rains of 1916 and it was noticed that the water in this well remained at a very high level for some days after all visible floods had receded and the stream had returned approximately to its normal level, which was several feet below the level of the water in the well. This was partly due to bad surface drainage, as some water which might have flowed off into the stream had been held back by numerous surface depressions and by a slight rise in the ground level, preventing its flow off in the direction of the stream, so that it had only been able to escape by sinking into the ground. Floods which spread slowly across the country and finally settle in badly drained areas at a distance from the main rivers and streams carry quantities of very fine silt which is deposited in the soil, thereby gradually destroying its porosity and making it of a more clayey nature. Near the streams, on the other hand, as the floods are always moving rapidly, they deposit coarser grains, which form porous soils. This process is always going on, and the natural tendency of the water round the roots of the trees to be in motion near the main lines of drainage is accentuated by the porous nature of the soil, while the natural tendency of the water to stagnate at a distance from the main lines of drainage is accentuated by the clayey, close-grained nature of the soil.

This explanation of the two types of Sal forest in Gorakhpur district was suggested by reading Howard's bulletins on Soil ventilation and Soil erosion (Pusa bulletins Nos. 52 and 53) and Hole's articles in the *Indian Forester*. It cannot of course be accepted as a correct explanation until detailed investigations have been made. If it is correct there does not appear to be much hope of improving the growing stock in the worst parts of the forest except by digging very deep, broad water-courses which would carry off the water as quickly as possible after floods, and promote a more rapid percolation of water through the soil during the period when it is liable to waterlogging—a measure which, besides being very costly, might do more harm than good as it would probably lead to considerable erosion and the exposure of the tree roots to the air. Surface drains to prevent the accumulation

of stagnant flood water by carrying it off to the streams as quickly as possible might, in course of time, do much to improve the growing stock. Experiments in surface draining on the system recommended by Howard in Pusa bulletin No. 53 are to be made shortly, but more in the hope of improving the condition of the surface soil for seed regeneration than of ultimately producing any marked effect on the established trees.

Failing an improvement of the growing stock by draining, it is a question whether Sal should not be replaced by *Terminalia tomentosa*, *Eugenia Jambolana* and *Pterocarpus Marsupium*, all three of which are useful timbers and do very much better than Sal in waterlogged localities. At present, however, the tracts containing the worst quality of Sal are usually those in which the proportion of Sal in the crop is exceptionally high. There must, therefore, have been a time when the soil was in a suitable condition for Sal, and it is possible that the deposits from annual floods of silt-laden water for centuries have been the main factor in reducing the forest to its present state. Under-planting the Sal with *Eugenia Jambolana*, and *Eugenia operculata*, both of which are undoubtedly soil-improvers, in Gorakhpur district, is a measure which may possibly be found very beneficial, especially if combined with surface-draining.

What has been written in this note is mainly a suggestion that the deeper roots of trees may suffer from bad aeration in the sub-soil. It must be remarked, however, that the tracts on which Sal forest of the poorer quality is found in Gorakhpur are usually tracts in which one would expect to find the surface roots of the trees affected by the injurious toxic substance which, as Hole has shown in his articles on the Œcology of Sal, is often operative in badly aerated surface soil. It is possible that this alone is enough to cause the difference between the two types of Sal in Gorakhpur. But probably both causes are at work. While referring to Hole's articles it may not be irrelevant to ask the following two questions:—

(1) Is the good effect of strip fellings on regeneration from seed entirely due to the exposure of the surface soil and the

removal of humus, or is it partly caused by the aeration of the soil through the death and destruction (by white-ants, etc.) of the roots of the trees removed at the fellings?

(2) Does the toxic substance appear to be more operative in soil mixed with Sal leaf humus than in soil mixed with humus from the leaves of other species?

The two types of Sal forest just described are natural; a division of the Gorakhpur Sal forests into three artificially created types may also be adopted, and these, for descriptive purposes, may be called B-1, B-2, and B-3.

Type B-1 (Nagwa, Sonari and part of East Lehra) consists of forests from which all the best stems were removed between 1830 and 1855,* and the rest tapped for resin.

In 1855 the remains of the growing stock, consisting of old defective stems and a certain amount of young coppice and seedling growth were protected by an order from the Collector which forbade the cutting of any of the more valuable species of tree. Since that time † these forests have had a complete rest except for cleanings of miscellaneous species and one very light improvement felling in *which only the worst of the decaying stems were dealt with.* The heavy exploitation of the forests before 1855 acted as a rough seeding felling and the 60 years of almost complete rest which ensued may be regarded as a regeneration period which has produced an irregular crop of Sal seedlings, saplings and poles over a great part of the area. Successful

* Before 1868 all the Gorakhpur Government forests were either waste lands under the Collector, or held by grantees who were bound by the terms of their grants to break up the land for cultivation. Most of the existing reserved forests was resumed by Government before 1855 from grantees who could not carry out their agreements to clear the land within a certain time, and consequently had their grants confiscated. Enormous tracts of Sal forest had been practically given away by Government to grantees who succeeded in clearing the land thoroughly. It is by a mere chance that the short-sighted forest policy of the Government of that time did not succeed in destroying the forests *entirely*, and that Gorakhpur still possesses a few Sal forests which have become almost the most paying in India.

† For the first few years the order was not strictly enforced and a few more trees appear to have been extracted.

fire-protection dates from 1875 only. About a third of the area could almost be clear felled now with the certainty of getting a good crop.

Type B-2 (Dudhai and part of East Lehra) consists of forests which were practically clear felled between 1830 and 1860 and since then left almost untouched except for cleanings of miscellaneous species and one very light improvement felling in which only the worst of the defective stems were removed. A thick crop, consisting mainly of coppice, grew up after the fellings between 1830 and 1860 and has developed into a more or less uniform forest which has suffered from want of thinnings. There are many defective stems, as until about 1870 the forests were burnt almost every year, and until about 1860 the larger poles were tapped for resin. In places where the crop is at all open there are often found big patches of good seedling regeneration of Sal. This type of forest may be regarded as uniform forest of 50 to 80 years of age well stocked with timber, mostly of coppice growth, which is in rather poor condition owing to want of attention in the past.

Type B-3 (The forests near Gorakhpur and the railway) consists of forests which were clear felled between 1830 and 1860 in the same way as the B-2 forests, and then left practically untouched for a time. Being near the railway * and the more thickly populated parts of the country, including Gorakhpur city, there soon grew up a demand for the poles and small timber and firewood which they could yield. Until quite recently, therefore, they received much more attention than any other forests in the division.

From 1868 to 1893 they were thinned. The method and intensity of thinning changed from time to time as Forest Officers came and went, but eventually settled down into regular operations which were called by different officers "thinnings," "improvement fellings," or "coppice-with-standards," and consisted of the felling of everything on the area except

* The railway was constructed in 1885.

160 of the best grown stems on each acre. The object of this was to produce uniform woods, the idea being to remove all the reserved trees after a certain time, leaving a young uniform crop of seedling and coppice growth. It is interesting to note that *no attempt* was ever made to work the Gorakhpur fosests on the Selection system. All the prescriptions ever laid down for their management had behind them the idea of getting them into a condition for management on a uniform system. The forests having been brought by the grantees who formerly owned them into a more or less uniform condition by the simple process of clear felling, it was taken for granted by every Forest Officer who saw them that they must remain uniform, and it never appears to have entered any one's head to suggest that they ought eventually to be brought into the condition of selection forests although this was apparently considered the right system in other Sal forests of the Province. This is suggestive, the more so as fires occasionally did considerable damage in the young uniform crops, and might have been considered an argument in favour of changing the character of the forests.* This system of working the forests remained in force till 1893, from which year until 1913 they were worked over on a 20-year rotation as coppice-with-standards, 60 standards being reserved per acre and the rest of the crop clear felled. This system was introduced to

* Fire-protection had been referred to in a Government resolution as an interesting experiment but not likely to be practicable on a large scale; and the following extract from the 1871-72 annual report of Gorakhpur Forest Division, which has been quoted before in the *Indian Forester*, is sufficiently illucinating to bear repetition:—"As directed by the Conservator, I tried my best to save the Government forests from fire, and had even spent Rs. 30 on removing grass bordering the forests, to prevent the fire from spreading when the grantees set fire to their forests; but I am sorry to say that all my preventive methods were of no use; the grantees burnt their forests as usual, and the fire extended to Government forests."

As a matter of fact the Gorakhpur Sal forests are not difficult to protect from fire if reasonable expenditure is incurred on the work. Since 1900 the area burnt has only once exceeded 1 per cent. of the total, the annual cost of fire-protection being about Rs. 2,600.

meet a special local demand for small poles and firewood. But even in carrying out these operations the idea of uniform forests appears to have been latent as the reserved standards were not selected with a view to the formation of a series of age-classes but were 60 of the best and largest trees on each acre and all of approximately the same age, so that in a short time after the fellings their crowns had spread out to form an almost complete canopy. This had to some extent the effect of seeding fellings * and the growing stock now consists of an overwood composed of from 30 to 60 standards per acre † (aged 50 to 80 years) and a 2 to 22-year old underwood of mixed coppice and seedling growth in which the coppice is, as a rule, suppressed by the overwood of standards and the seedlings by the coppice.

In 1913 the prescriptions of the working-plan of 1893 expired, and it had to be decided by what system to work the forests for the future. The advantages of a Uniform system are obvious ; the chief of them, perhaps, is simplicity in working. Among the main objections to the system as applied to Sal forests are : (1) the risk of damage from fire, frost, storms and insects, (2) the necessity of cutting, at the time of the final fellings and in thinnings, large quantities of material which is still unsaleable in most Indian forests and may, in the case of final fellings, do harm to the young crop unless considerable expense is incurred in removing it departmentally, and (3) the practical impossibility of establishing a complete young crop of anything approaching a uniform character without having some recourse to planting, an operation which is attended with special difficulties in the case of Sal. Most of these objections, however, apply with much less force to Gorakhpur division than to most Sal forests. Frost hardly ever occurs in Gorakhpur ; the forests are very easily protected from fire ; such a strong demand for small timber and firewood is growing up that it

* *Vide Indian Forester* for August 1911, pages 428—430 (article by A. E. Osmaston on the Gorakhpur coppice-with-standards forests).

† In some parts of the area the original sixty trees per acre have been much thinned out by drought and storms.

is already possible in parts of the division to make clear fellings with the certainty that every stick of the material will be removed quickly by purchasers; and finally, as the forests are of small size and surrounded by villages, there is no great difficulty in securing labour for making plantations and looking after them during the season when they most require attention, *i.e.*, during the rains. In the first two or three years after the final fellings, the growth of grass, weeds and miscellaneous shrubs during the rains is so rank that a plantation can hardly be expected to be a success unless it is carefully tended.

The revised working-plan, as eventually drawn up, is intended to prepare the way for a scheme which, if carried out, will ultimately bring the whole or almost the whole of the Gorakhpur Sal forests into the condition of regular uniform forests with a complete succession of age-classes. As the treatment recommended is emphatically experimental, and as the produce of final fellings in the more out-of-the-way forests cannot be completely disposed of until a few years hence (*i.e.*, until the construction of two branch railway lines, which has been delayed owing to the war), the working-plan was only written for a period of ten years and has to be revised in 1923-24 if not earlier. For this period of ten years the prescriptions are as follows:—

*The forests of type B-*1 are still too far from the railway for it to be possible to sell all the small material that the final fellings in the first periodic block would yield. Therefore the area is being worked over during the ten years with heavy improvement fellings and cleanings only; these will incidentally encourage natural regeneration to some extent and thereby prepare the way for uniform fellings ten years hence. Complete crops of seedling regeneration of Sal appear to be established so slowly and, when once established, retain their vitality for such a long period, even when growing under fairly heavy overwood, that in the writer's opinion it is not objectionable to have advance growth established in compartments that are not destined to be worked over with final fellings for a considerable time—even fifty or sixty years or more. Advance growth of this

age, after being more or less suppressed for most of its existence, would consist for the most part of poles or completely suppressed crooked saplings. The best of the poles might possibly be left at the time of the main fellings, but as Sal of this type coppices very strongly it would probably be found far better to cut them all down and let them grow up with the rest of the new crop from the ground. The difference in quality between coppice-grown and seedling-grown Sal trees after they have passed the pole stage requires investigation; it is not likely that really big timber can be grown except from seedlings or from saplings coppiced while still quite small, but it is possible, on the other hand, that healthy coppice shoots from older stools will develop into sound trees of $4\frac{1}{2}$ feet girth much more quickly than seedlings. Sal is such an exceptionally vigorous coppicer, and small Sal poles are in such very strong demand for building purposes in populous districts that deliberate coppicing of advance growth after final fellings on regenerated areas may become a regular feature of the uniform system as applied to Sal forests. It is doubted by some whether coppice-grown trees can produce good seed, but it has been observed in Gorakhpur that they are in no way inferior to seedling-grown trees in this respect.

The forests of type B-2 are being worked over temporarily with improvement fellings and cleanings in the same way, and for the same reason, as the forests of type B-1.

The forests of type B-3, however, being favoured by a demand which is strong enough to take all the material they can yield, are being worked under the most drastic variety of the Uniform system, *i.e.*, regular clear fellings by fixed areas, the average area worked over each year being equal to $\frac{\text{total area of Working circle}}{\text{rotation}}$. The object of this treatment is to meet the great local demand for Sal poles by converting the forests from their existing condition of so-called coppice-with-standards into uniform high forest on a short rotation (40 years); but as the whole crop including the seedling and coppice underwood is clear felled* the system might

* It is necessary to emphasize here that the forest is completely clear felled, nothing is left more than about 4 inches high.

be called by some coppice fellings on a long rotation. In a sense, of course, all Sal forests are coppice because, in the United Provinces at any rate, a Sal tree seldom grows straight up from seed without dying back. The reasons for cutting the underwood in this way at the same time as the overwood are: (1) the impossibility of cutting and removing the overwood alone without doing enormous damage to the underwood, and (2) the certainty that the existing underwood, after being suppressed for so long by the overwood and the miscellaneous species that have been allowed to grow up with it, can never develop well unless given a fresh start by being coppiced.

The coupes are laid down beforehand by fixed area. The first was worked over in 1914-15 and the resulting crop is very promising over most of the area. It is found that many of the seedlings and coppice shoots grow up crooked or are killed if heaps of brushwood and leaves are left lying on the gound after the fellings. It is important, therefore, to clear the ground thoroughly. The new crop is formed almost entirely from the underwood of the old crop, the strongest coppice shoots have sprung up from the stools left by small poles and saplings while the trees which formed the overwood have, as a rule, failed to coppice at all. In places when the ground is stocked with vigorous coppice stools, the young trees are already about 10 feet high and will suppress the growth of seedlings established in their neighbourhood. This is not considered objectionable, as strong coppice of this description is bound to be from young healthy stools and is very often the result of cutting back well-established seedling growth. Where coppice growth is thin or unhealthy there are generally almost enough seedlings on the ground to make a full crop, but they are liable to be held back by the rank growth which springs up during the first rains after the clear fellings. The grass has to be cut back annually until the seedlings are well established, and the soil is loosened and weeded round their roots during the rains. The grass can sometimes be sold for thatching material or fodder at a slight profit. Many miscellaneous species of little value grow up strongly from coppice after the fellings and threaten to suppress the Sal and other

valuable species. Cleanings are, therefore, carried out in the new crop in the 1st, 2nd, 5th and 10th years of its existence and after that cleanings combined with thinnings are laid down at intervals of ten years. The produce of these cleanings can be sold, but at a price which does not always cover the cost of the work.

But there still remains the problem of stocking blanks or partial blanks. A few bad patches of this kind must always be expected after the clear fellings. According to the working-plan this was to be done by reserving seed-bearers in open places at the time of the main fellings and wounding the soil around them, or by wounding the soil and sowing artificially without leaving seed-bearers. This method, though slow, would probably give successful results in time. Planting was not recommended because attempts to raise Sal trees elsewhere by this means have generally been failures unless considerable expenditure has been incurred on watering the plants regularly. In 1915, the first year after the adoption of the new working-plan, the Sal seeded profusely and considerable expenditure was, therefore, incurred on wounding the soil. The rains broke very late after practically all the Sal seed had lost its germinating power, and the expense of preparing the soil for it was consequently thrown away as far as the regeneration of Sal was concerned. Seeds of other species were afterwards collected and sown on the prepared soil but the results were poor.

In 1916, on the other hand, the rains broke unusually early but the whole forest did not produce enough Sal seed to sow up one small nursery, so no attempt was made to wound the soil.

It may be that in 1917 a good seed year will coincide with favourable rains; but, on the other hand, this happy combination of circumstances may not occur for many years.

As artificial regeneration by direct sowing gave such unsatisfactory results, experiments have been made in planting out Sal raised in nurseries, and fairly promising results have been attained by the following method :—The young Sal plants are raised from seed in an open nursery fully exposed to the sun. When they are about three years old they are dug up at the beginning of the rains, their roots being pruned at a depth of 18 inches and their tops cut

down almost to the ground so that the whole plant when ready for transplanting is only 19 or 20 inches long. They are then planted out in the forest into holes already prepared for them some three months beforehand. The holes measure 18 inches deep $\times 6$ inches in width, and are made with 'khurpas' at a cost of about 8 annas a hundred. They are dug not later than March, partly because labour is difficult to get after that but chiefly because the soil, which remains heaped by the side of each hole until the plant is put in, is improved by being 'weathered' for three months. The young plants send out fresh shoots within a few days of being pruned and transplanted. It was found in the case of a few which were transplanted more than a year ago that they do not usually grow more than 6 or 7 inches above ground during the first year but their roots increase in length from 1 foot to 2½ feet in the same period.

The following are points that have been specially observed in connection with the transplanting :—

(1) Plants raised in a nursery exposed to the full glare of the sunlight have given good results, but naturally-grown plants dug out of the forest to supplement the supply from the nursery have done very badly, most having died before the end of the rains.

(2) The best results appear to be obtained by transplanting during the first fortnight after the break of the rains, which is a time of very vigorous growth. Transplanting before the rains would probably give still better results but only if the plants were watered ; without water they nearly all die if transplanted before the rains, as has been found by experiment.

(3) Careful weeding and cutting back of the rank grass which grows up very soon after the clear fellings in all poorly stocked places is necessary, and the transplants do better if the soil round each plant is kept loose during the rains with a 'khurpa.'

(4) The plants do not require watering but survive until the following rains, by which time they may be regarded as fairly well established.

The results of this experiment are sufficiently promising to encourage the hope that transplanting may always be relied upon for filling up blanks with Sal, but it is too early to be quite sure about this. The young plants will probably take some years to grow up above the grass and miscellaneous shrubs that surround them and during this period they must be tended and weeded annually, especially during the rains.

It is open to question, too, whether trees raised in this way will remain sound as long as naturally regenerated trees. It is generally said at home that oak plants, if transplanted after their tap-roots have been cut, develop into trees of inferior quality which decay at an early age.

Nurseries are being laid out now with a view to transplanting Sal on a large scale in the future and the experience gained now in transplanting will be used when uniform working is started in the other forests of the division.

This note has been written because it was suggested that the results of the clear fellings and the small experiment in transplanting might be of some general interest. The main interest of the Gorakhpur forests lies in the fact that they will probably be the first Sal forests in which it will be practical politics to introduce intensive methods of work approaching European standards. They have passed very quickly through the stages of development from an unwieldy tract of supposed worthless jungle to valuable woods with an intensive demand. The same process is going on elsewhere but more slowly.

* * * * *

EXTRACTS.

THE FOREST DEPARTMENT.

The little publication edited by Mr. Troup, Assistant Inspector-General of Forests, entitled The Work of the Forest Department in India, is one that (as such monographs are intended to do) suggests more than it discloses as to what the Forest Department means to India. Were such writings more read than they are they would serve to awaken public interest in an undertaking which few people are brought in touch with or of course trouble about. Railways? Yes—do we not all see them and use them and invest our money in them? And consequently, do we not want more and still more of them, and get angry with the Government of India for not providing what we want? But the forests—what do we see of them? When we pass through one on the railway the train seldom stops, we are dimly conscious of some trees of some kind standing about dismally and shutting out the light and air, we are glad to be in the open again, and if we ever thought of it, at once forget that we have just left

behind us what when properly considered is a mine of India's wealth. Moreover, no one has ever asked us to invest our money in this mine and so we refuse to believe that it is any such thing. This is what we say and what does Mr. Troup himself say in the very first words he writes? "It may safely be said that there is hardly any Government Department in India whose work and aims are so little realized by the general public as are those of the Forest Department. For one thing the work of the forest officer lies for the most part in remote places, so that few have any knowledge of it. For another the practical results of forest work are apparent only after long periods of time, so that the forest officer has to cultivate the habit of thinking in half centuries and to be content that the full effect of his labours shall be visible only to future generations." Now in India there are but two forces that may be looked to to effect any large administrative reform. One is the driving power of a strong executive head provided he be the head of a Province, or an officer holding a portfolio under the Government of India; the other is a strong united public opinion. The head of the Forest Department is the Inspector-General of Forests who is no more than a technical adviser to the Government of India, while the official who holds the portfolio is the member in charge of the Department of Revenue and Agriculture who of course never can be a forest officer. The driving force necessary to re-cast the Department is, therefore, never likely to come from that quarter; and if it is to come into existence at all it must be created by strong public opinion. Mr. Troup writes his little book for the purpose of awakening this opinion, and we wish him every success in his effort.

Perhaps, on the whole, what has so far been done by the Government of India for the development of forests is to be commended rather than condemned. We must remember that after all, administration in this country is but a reflex of what it is at Home. There, for many years past, there has never been a forest policy; the country could get its timber cheap from neighbouring and poorer countries and was content to do so while its own forest lands were allowed to become uncontrolled game

preserves and private parks. That British rulers in this country have gone so far as they have done in developing a forest policy, may, we think for this reason, be considered as so much to their credit; we have always felt this and Mr. Troup confirms it. In 1855 Lord Dalhousie framed a definite policy and that policy has since been systematically maintained and extended, so that now more than one-fifth of British India is controlled by that policy more or less under the classification of—(1) reserved forest, (2) protected forest and (3) unclassed forest. Areas are steadily being transferred from a lower to a higher class and the position on 30th June 1915 stood thus:—Out of a total of 249,867 square miles, class (1) comprised 97,580, class (2) 10,405 and class (3) 141,882. There is but little to quarrel with in this broad result; but we may fairly ask if the time has not now come for proceeding from a general to a detailed policy, for building on the foundation so wisely laid and strengthened, for producing the finished structure which, like the completed building, will pay on its outlay. This is looking at the question from the direct commercial point of view, but there are other considerations too. Forests must be preserved for the sake of their effect on rainfall (though this effect may be small), they must also be preserved to prevent denudation of soil and to maintain an underground supply of water for purposes of stream regulation—all indirect purposes, the neglect of which must entail widespread injury and loss. Moreover, were the forests to disappear what would be the position of the agricultural population?—a section of the population that has necessarily to be protected against its own folly and improvidence. The task of the Forest Department is thus seen to be a dual one, *viz.*, preservation for indirect benefits to the country and extension and exploitation for the sake of commercial returns. The first task is well in hand and the Department may now be said to be entering on the second on a commercial scale. How far it will progress on this road will depend on the extent to which Government is prepared to finance it. Money is wanted for communications, for up-to-date methods of transportation, for givinig the lead to forest industries, such as timber preservation, turpentine extraction,

paper-pulp manufacture and a host of others of minor importance Will the money be forthcoming? It depends much on the energy with which it is solicited.

A few words regarding the three major industries we have indicated are called for. First, there is the antiseptic treatment of timber which was taken up departmentally some seven years ago; the oldest sleepers have now been in the line for more than five years and are still in good condition. Five of the second quality timbers were employed and four kinds of antiseptic, and it yet remains to be seen which timber and which antiseptic gives the best results, though the general good effect of treatment may be taken to be already established. There are thus vast possibilities opened up for the utilization of the second class timbers of India, and it is now up to the Government to see that communications and methods of exploitation are provided that will make the use of these timbers more profitable than the importation of preserved timbers from abroad. Turning to the Indian pine-resin industry, it is satisfactory to find that in the last five years much has been done in the United Provinces and Punjab to utilize the Chir pine for the production of resin and turpentine on scientific lines.

To quote Mr. Troup—" For the year ending 30th June 1916, the combined output in the United Provinces and the Punjab was 67,078 maunds of resin distilled, yielding 47,149 maunds of rosin and 111,835 gallons of turpentine, all classes. The gross revenue was Rs. 5,04,249, the gross trading account profit Rs. 1,73,892, and the net trading account profit Rs. 1,46,794, while the invested capital stood at Rs. 1,61,905." This revenue is only a fraction of the return which may one day be realized and it has the unique advantage of being just so much return over and above the return from the timber itself which, after antiseptic treatment, makes a serviceable sleeper. But the possibilities that lie behind development of the paper-pulp industry may have more far-reaching results than any. With five Indian paper mills at present being run at Titaghur, Kankinara, Raniganj, Lucknow and Poona the manufacture of paper in India may be said to be in its infancy. Of the 30,000 tons of paper being manufactured at the present

time annually in India, two-thirds are made at Titaghur and Kankinara (which are really under a single agency and only a few miles apart) and the expansion of outturn by this combined concern may be very great now that bamboo-pulp is to be definitely obtained by them from Burma. There is no longer a doubt of this pulp being able to replace imported wood-pulp commercially, and there is, therefore, every prospect of India becoming independent of the European market in the near future in regard to its supplies both of paper-pulp and of paper. Only one-third of the paper demand in the country is now met by the Indian mills; when the whole of the 75,000 tons required can be produced it will be but a step to India becoming an exporter of paper to all countries east of India and to many adjacent ones besides. The supply of bamboos and grasses is unlimited, so it is difficult to set a limit to the expansion of the paper industry.

A mere glance at what Mr. Troup's brochure sets forth is all that it is possible to attempt here. We trust that so much as has been said will awaken an interest in the subject and induce those concerned about the development of Indian industries to read the pamphlet carefully. They will find much food for thought in it and matter worthy of wide ventilation which, if pressed upon those ready to take up enterprises, will open many profitable avenues for exploitation.—[*Indian Engineering*.]

LANTANA CONTROL.

Lantana has proved itself a troublesome weed in a number of countries, the Sandwich Inlands, New Caledonia, Fiji, and Honolulu amongst others. In India it has overrun large areas, spoiling the grazing and forming a harbourage to pigs. From the planter's point of view Lantana is rather a beneficial weed than otherwise; he can easily keep it out of his cultivation which is regularly weeded, and on unplanted land it forms an excellent cover which protects the soil from wash and at the same time adds to its fertility by depositing a rich layer of humus derived from the fallen leaves. Moreover, it contains a very high proportion

of potash in its ash derived to a great extent from the deeper layers of soil reached by its roots. An analysis made by Dr. Lehmann showed that Lantana ash contained as much potash as kainit, a total of 15·75. Unfortunately the leaves, twigs, and branches only yield about 2 per cent. of ash.

To the ryot, however, it is undoubtedly a pest and it is apt to be troublesome in the forest though its relation to Sandal has not yet been definitely determined, and attempts have been made to control its spread and even to exterminate it, more especially in Coorg. In Mexico, where Lantana is indigenous, it is attacked by a small fly which lays its eggs in the young berry and the resulting larva eats the berry and thus kills the seed and checks the spread of the bush. This fly was introduced into Honolulu with excellent results, and it was then introduced into New Caledonia and Fiji. The latest country to try this experiment is Queensland where a large number of flies from Fiji and Honolulu have been liberated.

Before such a check on the growth and spread of Lantana could be tried with safety in South India it would, writes Mr. Rudolf Anstead, Deputy Director of Agriculture, Mysore, in the *Planters' Chronicle*, have to be ascertained with certainty that the fly will not attack other crops besides Lantana. It is possible for instance that it might devote its attention to coffee berries and cause more damage to a staple crop of this kind than the Lantana does.

During his visit to Coorg in 1913 in connection with the question of bees and the pollination of coffee, Mr. Bainbrigge Fletcher, the Imperial Entomologist, discovered an insect attacking the fruits of Lantana in much the same way that this fly in Mexico does. He thus records it in his report (*P. C., VIII., p. 61*), "Lantana was freely attacked by a small Plume moth (*Platyptilia pusillidactyla*) whose larva bores into and practically destroys the young seed head, so that an attacked seed head bears only three or four weakly looking fruits, whereas a normal unattacked head may bear fifteen or sixteen plump healthy fruits. A few caterpillars cut the leaves, but such do practically nothing to check the growth of a plant like Lantana, whereas this little moth checks its spread

directly by limiting its power of dispersal by seeds eaten and carried by vertebrates."

This observation was made at Mercara, but apparently, the moth makes little headway with the Lantana there. We understand that an Entomological Assistant has been, or is about to be, deputed to Coorg on special duty with the object of studying the Lantana question in all its details, and no doubt he will take into consideration the possibilities of control both by means of this Plume moth and the Mexican fly.—[*Indian Planters' Gazette.*]

SHORTAGE OF LACQUER IN FAR EAST.

A Burmese Substitute.

A shortage of lacquer materials is reported in the Chinese and Japanese lacquer-ware trade, in which the most important material used is a natural varnish consisting of the sap of the tree *Rhus vernicifera.* This shortage may afford an opening for trade in the very similar product of Burma known as "thitsi."

The largest consumption of lacquer varnish is in Japan, where it is used in the manufacture of the ordinary lacquer-ware of commerce, and also for varnishing carriages, musical instruments, and other fine wood-work. Of the varnish used in Japan about 70 per cent. is imported from China. It is reported that the demand for lacquer varnish in Japan has increased in recent years more rapidly than the supply, with the result that the quality of the supplies, particularly those imported from China, has deteriorated owing to adulteration with products such as T'ung oil (Chinese wood oil).

A product known as "thitsi," very similar to the natural lacquer varnish of China and Japan, is obtained in Burma from the Black Varnish tree, *Melanorrhœa usitata,* by tapping. The chemical composition of "thitsi," or Burmese varnish, has been investigated, and its principal constituents found to be identical with those of Japanese lacquer. The moist atmospheric conditions necessary in the process of hardening Japanese lacquer are also

required in the case of "thitsi." In Burma "thitsi" is used as a varnish for wood-work, to render cloth or paper waterproof, as in the manufacture of Burmese umbrellas, and to cover articles of wood or basket-ware for domestic or religious use. Several kinds of Burmese lacquer-ware are produced with "thitsi," such as the lacquered basket work of Pagan, the Prome gold-lacquered ware, the moulded lacquer-ware of Mandalay, and the Manipur varnished ware. Thitsi is also the cement used in making Burmese glass mosaics. It has been suggested that, with the artistic ability of the Burmans and a raw material at hand which has proved equal to that used by the Japanese craftsmen, a much larger lacquer industry might be developed in Burma than that which exists at present. The immediate suggestion is that advantage should be taken of the present opportunity of exporting the raw material, large supplies of which exist in Burma, to Japan.—TIMES' TRADE SUPPLEMENT, March 1917.—[Reprinted in *Tropical Agriculturist.*]

[An exhaustive note on Thitsi has lately been issued in the form of a Forest Record (Vol. VI, Part III) from the Forest Research Institute, Dehra Dun.—HON. ED.]

MAKING PAPER BOTTLES.

A new American paper-bottle machine is about 100 feet long, is operated by three men, and makes 5,000 sanitary milk containers an hour, each bottle being finished from raw pulp in about eight minutes. Pulp from other fibrous woods besides spruce can be used, one ton sufficing for 60,000 bottles. The pulp is taken up on a steel core, rotated under clamps that press into a seamless body, next passed into a drier and over a marking stencil, and then automatically taken from the core and passed by a belt that feeds it to a machine crimping on the bottom and top. The bottle is finished and made impervious to liquids in a bath of paraffin.—[*Capital.*]

CELLULOSE PULP FROM SEAWEED.

His Majesty's Consul at Palermo (Mr. R. G. Macbean, M.V.O.) reports to the Board of Trade under date 10th March, that, according to the local press, a patent has been granted in Italy for a process, the discovery of a local inventor, for the production of cellulose pulp from seaweed, for the manufacture of paper. The patentee intends to establish a factory for producing cellulose, and also a paper mill.—[*The Indian Trade Journal.*]

TEAK IN JAVA.

The Forest Department have issued a report* on Teak in Java and Madoera Islands. We possess very little information on the conditions under which this valuable timber tree is grown in the Dutch East Indies and perhaps none later than Van Vreden's Teak culture in Java which was reviewed in the *Indian Forester* years ago. The subject is of interest both from the commercial and the industrial stand-point. The authorities concerned are therefore to be congratulated on having published Mr. Milward's observations on the Java forests. They richly deserve to be saved from the semi-oblivion of Government records. There is a key-note of refreshing honesty throughout the report even though the results recorded must necessarily be of a superficial character. The author himself acknowledges that his examination of the Dutch plantations extended over the period of five days only!

Teak and its reproduction has always been a difficult subject. Beddome, Brandis, Gamble and many lesser lights have no doubt done a good deal for Indian Forestry but they cannot, any of them, claim to have uttered the *quaderat faciendum* over this problem. To the Indian Forester therefore it still continues to be the question of questions and as far from finality as ever before. This leads to the not unnatural suspicion that in this

* *Note on the Forests of Java and Madoera of the Dutch East Indies*, by R. C. Milward. Price annas 13. Calcutta: Superintendent, Govt. Printing, India, 1915.

respect at least perhaps the old Burmese system, in spite of its white elephant traditions, knew how to manage things better. It could not certainly have been accused of extravagance in the upkeep of the teak forests and yet the outturn, in those prehistoric days of low prices and limited demand, was very far ahead of the tolerable.

In British India alone there are at least four distinct schools of operations in order to obtain a fair reproduction of teak and thus to create a reserve against a possible exhaustion in the future. In Nilambur, in Central India and near Darjeeling the process adopted is that of plantation, pure and simple. In Burma, which is reckoned to be the most important centre of teak supply, the taungya system of cultivation with its regulation number of annual additions in saplings has, so far, yielded fairly good results. Next comes natural reproduction. It, however, involves an enormous expenditure of labour and money, but the results are often of merely temporary benefit, thus producing a minimum effect with a maximum outlay. Coppicing is also much practised almost everywhere, but expert opinion seems to be rather divided on the value of artificial reproduction and its influence upon the quality of timber.

The Dutch Government have almost from the very outset come to the definite conclusion that the management of natural teak forests is not only difficult and expensive, but is, on the whole, uncertain. They have, therefore, substituted instead, a wholesale system of plantation. Gamble quotes, in his new edition of Indian Timbers, the estimated acreage of teak plantations in Java at about 84,000 acres. Mr. Milward gives the total area of teak alone as 2,655 square miles. This does not include the unreserved forests which also contain a fair percentage of good teak.

Van Vreden in his paper mentioned above has a very interesting note on the selection of crops that are profitably grown in the interspaces between the lines of young teak in the Java plantations. He has succeeded in showing that this process of linking agriculture with forest conservancy not only secures a regular careful

and cheap working of the land, but also materially helps towards obtaining a larger supply of the products that are useful for the sustenance or happiness of human life. Mr. Milward, however, is here true to his Indian experience and has no valuable information to offer on this point. He confines his remarks to a mere skin-deep comparison with the Burmese taungya cultivation. There are, however, essential points of difference between the system that holds in Java and that in Burma. The principal advantage of the latter lies in its shifting area of which there is admittedly very little in Java. Nor do we obtain anything definite as to the particular kinds of crops that are most favoured. It is remarkable to note that the Dutch officers are very keen in having as many interplantings of teak as possible sown with *Leucæna glauca.* This partiality may, for all that appears to the contrary, be due to its being a leguminous plant. We have, however, no means to discover if any leguminous crop like that of the ground-nut is grown, specially foliage which keeps the undergrowth well in check, or for the larger amount of nitrogenous matter it puts into the soil and thus serves to secure a higher rate of growth for teak.

The exploitation of teak in Java has, we find, become practically double if not treble of what it was in 1903, and this rate of increase with the last ten or twelve years bespeak a considerable amount of development. The demand for teak in the home market of Java is also reported to be great. Its exports outside the Dutch East Indies amounted in 1907 to 2,296,245 c. ft., which, however, fell in 1912 to 1,710,065 c. ft., out of which only 142,625 c. ft. were sent out to India. This represents about 10 to 11 per cent. It would have been of much greater interest and value to know of the destination of the major portion or at least how much of it finds its way from these islands to Europe.

The remarks about personnel, management, scale of pay and fellings are mere departmental details. But the advice with which Mr. Milward concludes his report is very sound and deserves attention. That the Indian Forest Department would derive much benefit by deputing one or two of their capable officers to study the Dutch system in more detail, there can be no question.

Constant working in a traditional groove does certainly result in a cramping of the powers of observation. It is therefore essential that those who have the improvement of our teak forests at heart should enlarge their horizon by carefully marking and digesting what others have done and are doing outside our own restricted area. The world does not stand still even if we be inert is a truism that would well bear repetition.—[*Capital.*]

These photos illustrate **Mr. Haine's article** on "**A New Species of Acacia**" published in *Indian Forester*, February, 1917.

Photo.-Mechl. Dept., Thomason College, Roorkee.

FIG. 1.—ACACIA PENNATA.

FIG. 2.—ACACIA DONALDI.

VOLUME XLIII NUMBERS 11 & 12

INDIAN FORESTER

NOVEMBER & DECEMBER, 1917.

BEST METHOD OF WORKING *ULLA* GRASSLANDS.

BY R. S. HOLE, I.F.S., FOREST BOTANIST.

Proposal to work *ulla* for paper pulp.

1. The value of *ulla* grass (*Anthistiria gigantea*, Cav., sub-species *arundinacea*, Hackel) as a paper-pulp material was first established at the Allahabad Exhibition of 1910 when, at the instance of Mr. P. H. Clutterbuck, Conservator of Forests, samples were submitted to, and examined by, the well-known pulp-expert, Mr. William Raitt. As a result of this discovery the establishment of a paper-pulp factory in the Pilibhit Division of the United Provinces was proposed and it then became necessary to determine the best method of cropping this grass with the object of obtaining a sustained maximum yield per unit of area, especially of flowering culms which constitute the most valuable portion of the

crop both as regards the quantity and quality of the pulp produced by them.

Factors likely to reduce the yield of *ulla*.

2. Among the factors likely to reduce the yield of grass in the case of this species are the following :—

(1) *Damage by cutting.*—If a plant of *ulla* is examined in the cold season in Northern India, it will usually be found that the majority of the culms which are to produce the next year's crop have already started growth and are visible as tufts of more or less well-developed green leaves. If these leafy culms are allowed to develop normally they will flower in the following cold season and will attain an average height of 12—15 feet. These culms which exist as leafy shoots at the time of cutting the crop and which require more than one full year to attain maturity may be distinguished as biennial culms, although they actually require only one full year and a portion of another for their development. If, when the grass crop is cut, the biennial culms are cut which then exist as immature leafy shoots, the normal development of the latter is checked and their ultimate dimensions (as well as the final yield of grass) diminished. In January 1916, the writer dug up and examined 44 *ulla* plants in different parts of the Pilibhit grasslands and these contained 192 flowering culms, 61 culms which had died prematurely without flowering (chiefly owing to the attacks of insects and fungi), and 163 green leafy culms. The dead and flowering culms together constitute the legitimate final crop which can be annually removed without diminishing the vigour of the plant and in this case they total 253 culms. The above figures, therefore, show that approximately two-thirds of the culms constituting the crop of next cold season (*viz.*, 163 culms) had already started growth in January and, owing to the labour conditions in Pilibhit, it is improbable that most of the *ulla* crop will be cut earlier than January. In the Pilibhit grasslands the leaves on the immature leafy culms are, no doubt, more or less injured by frost in December—January, but the damage then done is certainly less than would be caused by cutting the shoots a few inches above the ground. The weakening effect of cutting

might be avoided by adopting a two years' rotation. The culms of his species, however, are very brittle at the nodes and after flowering they soon fall to the ground and rot. A two years' rotation, therefore, is inadvisable, inasmuch as this would necessitate the loss of the legitimate yield every alternate year while the accumulation of débris would increase inflammability and the difficulty of harvesting the final crop. From this point of view, therefore, it seems advisable that cuttings should be annual but should bear only on the flowering and dead culms, the living leafy culms being spared.

In this connection, also, it should be noted that, according to Mr. Raitt, *the inclusion of immature leaf in the cut crop is a* serious drawback from the point of view of the paper manufacturer inasmuch as it causes agglutination and also interferes with the bleaching.

(2) *Damage by fire.*—The comparatively dry grasslands of Pilibhit are very liable to fire damage.

A late fire in this locality in April—May is, as a rule, very destructive and burns and kills all the *ulla* shoots down to the ground. In such cases, therefore, the final crop of the ensuing cold weather is enormously reduced, inasmuch as it consists of culms which have enjoyed about half the normal period of growth. Assuming that fire cannot be prevented, the damage done could be diminished by burning purposely as early in the season as possible, immediately after cutting. A considerable quantity of moisture in the soil is required for the vigorous development of *ulla* and it is probable that continued early burning may gradually reduce the yield by diminishing the quantity of organic matter and moisture in the soil.

(3) *Damage by grazing.*—The young shoots of *ulla* are extensively eaten by deer, nilgae and other animals. Fires facilitate the access of animals to the young shoots and thus increase this damage which, by preventing the normal growth of the young culms in the hot season, is most detrimental to the *ulla* crop.

3. In the light of the above remarks, therefore, it appeared to be advisable to obtain definite information as to the comparative merits of the following methods of treatment in the Pilibhit grasslands :—

Local experiments to determine best method of working.

(i) Cutting all shoots, flowering and leafy, and burning the area as soon as possible after cutting.

(ii) Cutting all shoots, flowering and leafy, and then protecting the area from fire.

(iii) Cutting only the flowering and dead shoots and burning, as soon as possible, after cutting.

(iv) Cutting only the flowering and dead shoots and then protecting the area from fire.

At the request of Mr. P. H. Clutterbuck, Chief Conservator of Forests, therefore, the writer drew up a scheme which provided for the selection of eight local experimental areas designated A—H, respectively. Of these, four, A—D, were situated in areas recently burnt and the rest, E—H, in areas which had been long protected. Each area consisted of three adjacent plots, numbered (1)—(3) consecutively, and the area of each plot was 1 acre. In plot (1), in all cases, everything to be cut while in plots (2) and (3) only flowering and dead shoots were to be removed. In A, D, E and G, plot (1) was to be burnt after cutting, and in B, C, F and H to be protected. In all cases, plot (2) was to be burnt after cutting and plot (3) protected. The plots were laid out by the Divisional Officer, Lala Gulab Rai, and were visited by the writer in 1916 and again in 1917.

4. The yields of dry grass obtained at the close of the first year's treatment are given in the statement below. The figures in large type give the yield of flowering culms only, the other figures give the total yield of all the shoots cut :—

Results obtained at close of first year's treatment.

Number and acreage of plot.		A(1) 1·03 acres.	D(1) 1·03 acres.	E(1) 1·03 acres.	G(1) 1·0 acre.					Total yield in lbs.	Percentage increase or decrease of yield at the close of first year's treatment.	REMARKS.
Method of treatment.	Year.	Yield of dry grass in lbs.										
(I) All shoots cut and area burnt as soon as possible after cutting.	1916	3,634	3,096	2,948	2,757	...	...	...	...	12,435	Decrease	Annual area cut = 4·09 acres.
		848	**882**	**2,7[illegible]**	**1,148**					**5,630**	38%	
	1917	1,231	2,119	3,009	1,410	...	...	...	...	7,769	**61%**	
		175	**527**	**1,169**	**336**					**2,207**		
Number and acreage of plot.		B(1) 1·02 acres.	C(1) 1·03 acres.	F(1) 1·03 acres.	H(1) 1·0 acre.							
Method of treatment.	Year.	Yield of dry grass in lbs.										
(II) All shoots cut and area then protected.	1916	2,152	3,392	3,113	2,232	...	...	...	...	10,889	Decrease	Annual area cut = 4·08 acres.
		435	**772**	**2,818**	**1,372**					**5,397**	20%	
	1917	1,240	2,268	3,015	2,221	...	...	...	...	8,744	**22%**	
		260	**450**	**2,077**	**1,425**					**4,212**		

Number and acreage of plot.		A(2) 1·03 acres.	B(2) 1·02 acres.	C(2) 1·03 acres.	D(2) 1·03 acres.	E(2) 1·03 acres.	F(2) 1·03 acres.	G(2) 1·0 acre.	H(2) 1·0 acre.	Total yield in lbs.	Percentage increase or decrease of yield at the close of first year's treatment.	REMARKS.
Method of treatment.	Year.	Yield of dry grass in lbs.										
(III) Only flowering and dead shoots cut and area burnt as soon as possible after cutting.	1916	558	378	480	872	2,394 2,337	2,421 2,340	1,355 1,135	1,495 1,336	9,953 9,436	Decrease 49%	Annual area cut = 8·17 acres.
	1917	648 433	361 250	295 215	920 830	1,099 1,071	963 905	272 272	560 514	5,118 4,490	52%	
Number and acreage of plot.		A(3) 1·03 acres.	B(3) 1·02 acres.	C(3) 1·03 acres.	D(3) 1·03 acres.	E(3) 1·03 acres.	F(3) 1·03 acres.	G(3) 1·0 acre.	H(3) 1·0 acre.			
Method of treatment.	Year.	Yield of dry grass in lbs.										
(IV) Only flowering and dead shoots cut and area then protected.	1916	596	558	648	634	2,340 2,289	2,261 2,191	1,218 1,020	1,336 1,122	9,591 9,058	Increase 82%	Annual area cut = 8·17 acres.
	1917	2,015 1,803	1,885 1,720	1,678 1,512	2,290 2,146	3,563 3,510	2,998 2,933	1,506 1,466	1,495 1,460	17,430 16,550	83%	

The above results obtained from an aggregate area of 24 acres obviously indicate the outstanding superiority of treatment IV, *i.e.*, annual cutting only of flowering and dead culms coupled with fire-protection.

Partial cutting better results than clear cutting.

5. As regards the advantages of cutting only flowering and dead shoots as compared with cutting all the shoots, the following statement gives eight comparisons, each comparison dealing with adjacent plots in one and the same experimental area :—

I.—PLOTS PROTECTED AFTER CUTTING.

Plot.		B(1)	C(1)	F(1)	H(1)	REMARKS.
Treatment.	Year.	Yield dry grass lbs.	Yield dry grass lbs.	Yield dry grass lbs.	Yield dry grass lbs.	Areas B and C are situated in a grassland which was accidentally burnt in 1915, F and H are in long-protected grasslands.
All shoots cut ...	1916	435	772	2,818	1,372	
	1917	260	450	2,077	1,425	
Result ...	+	−175	−322	−741	+53	
	−	−40%	−42%	−26%	+4%	In all cases the yield is of flowering culms only.
Plot.		B(3)	C(3)	F(3)	H(3)	
Only flowering and dead shoots cut.	1916	558	648	2,191	1,122	
	1917	1,720	1,512	2,933	1,460	
Result ...	+	+1,162	+864	+742	+338	
	−	+208%	+133%	+34%	+30%	

II.—PLOTS BURNT AFTER CUTTING.

Plot.		A(1)	D(1)	E(1)	G(1)	REMARKS.
Treatment.	Year.	Yield dry grass lbs.	Yield dry grass lbs.	Yield dry grass lbs.	Yield dry grass lbs.	Areas A and D are situated in a grassland which was accidentally burnt in 1915, E and G are in long-protected grasslands.
All shoots cut ...	1916 1917	848 175	882 527	2,752 1,169	1,148 336	
Result ...	+ −	−673 −79%	−355 −40%	−1,583 −58%	−812 −71%	In all cases the yield is of flowering culms only.
Plot.		A(2)	D(2)	E(2)	G(2)	
Only flowering and dead shoots cut.	1916 1917	558 433	872 830	2,337 1,071	1,135 272	
Result ...	+ −	−125 −22%	−42 −5%	−1,266 −54%	−863 −76%	

Thus, out of the eight comparisons, cutting only flowering and dead shoots shows distinctly the best results in six cases. In the remaining two cases, in the burnt plots of areas E and G, there is practically no difference between the two methods. These two areas are situated in long-protected grasslands and it is probable that in them the fire damage was sufficiently severe on account of the accumulation of débris to destroy the leafy shoots which had been spared in the cutting, the advantages of partial cutting being thus eliminated. If this is the case, the partially cut plots should show an improvement in subsequent years as compared with the completely cut plots. From the data at present available the cost of cutting all the shoots comes to Re. 1-5-4 per 1,000 lbs. of dry grass, while the cost of cutting only the flowering and dead culms comes to Re. 1-12-1 per 1,000 lbs. In considering this question, also, it must be remembered that what appears to be only an insignificant decrease in the yield may really be of great importance if it tends to be cumulative over a period of years. From this point of view, therefore, it is obviously advisable to avoid as far as possible any treatment which is at all likely to weaken the plant and reduce the yield.

6. As regards fire, the yield figures quoted above clearly indicate the great advantages of protection. *It may, however, be argued* that as it is extremely difficult to insure successful protection and entire immunity from this source of damage, it may be preferable to burn the areas intentionally as early in the season as possible and thus to secure comparative safety from the far more injurious late fires. Under the existing fire-protection arrangements the average annual area burnt during the last ten years in the protected Pilibhit *ulla* grasslands has been 17 per cent. The total area of the *ulla* grasslands is estimated at 17,152 acres and the average annual area likely to be burnt is thus 2,916 acres. An area burnt late in the season in say April—May 1915 will yield practically nothing in the cold season of 1915 but will, if protected, give a fairly normal yield in the cold season of 1916. In these dry grasslands *ulla* does not attain its maximum development and it is probable that the average annual yield of flowering and dead culms is here about 1 ton per acre. Under fire-protection, therefore, the average annual yield is estimated at:

Fire-protection advisable.

17,152 (total area in acres) – 2,916 (annual area burnt in acres) = **14,236 tons.**

Now, under a system of annual early firing, the annual yield cannot be estimated at more than one-third the normal, *vide* the figures for treatment III and IV respectively given in para. 4 above.

Under this system, therefore, the average annual yield would be $\frac{17,152}{3}$ = **5,717 tons.** The balance of advantage in favour of fire-protection, therefore, is very considerable.

7. It is of course inadvisable to lay too much stress on the results obtained after only one year's treatment but as, in the present case, they are so consistently and strongly in favour of treatment IV (annual cutting only of flowering and dead culms coupled with fire-protection) there is no doubt that this is the best treatment to adopt at present until

Best system to adopt at resent.

Experiments to be continued.

further evidence is available to the contrary. It is, moreover, obviously satisfactory to have obtained so definite a result in such a short period and this is mainly due to the care and ability with which these experiments have been carried out by the Divisional Forest Officer, Lala Gulab Rai. Efforts should be made to increase the yield by improving the fire-protection arrangements and by increasing the proportion of *ulla* in the crop by artificial propagation. By steadily increasing the yield per unit of area, the cost of collection and transport of the grass will also be diminished. The experiments now reported on should obviously be continued for a number of years in order to get an idea of the cumulative effect of the different treatments after a considerable period. An additional set of experimental areas has also been selected this year with the object of showing the effect of a treatment of (1) alternate burning and protection, and (2) alternate complete and partial cutting.

STRAY NOTES ON THE WORKING OF TEAK IN BURMA.

BY A. J. BUTTERWICK, P.F.S.

1. Before commencing these stray notes, the writer begs it to be understood that the remarks and statements made by him below are only his humble opinions and the impressions of a beginner in the science of Practical Forestry. These notes are simply the outcome of careful observations made during the writer's short experience in the Burma Forest Service, chiefly in the Pyinmana Forest Division, one of the most important in Burma. It may be remarked with regard to any discussion on the exceedingly complicated subject of the successful working of teak, that "fools rush in, where angels fear to tread." The writer frankly confesses that he is a fool in the extent of his knowledge of teak; but, at any rate, he is one, who has taken more than an ordinary interest in his daily work and is willing to be enlightened and disabused of any erroneous impressions he may have formed.

2. All the teak forests, which the writer has hitherto worked in, have been managed on the Selection system, that is, a certain number of teak trees of, and above, a certain exploitable girth are selected and girdled in each compartment as laid down by the Working Plans Officer. These trees are afterwards felled and extracted by the lessees. Now, in these forests, the teak crop has by no means, been normal, that is, the different age-classes have not been proportionately represented. This state is due, partly to the heavy unrestricted fellings in the past of 5′—7′ girth trees, and partly, to the want, in the past, of protection and silvicultural treatment. The teak crop, as found, has invariably consisted of large-sized over-mature trees, varying in girth from 9′—16′ and sometimes over, and growing in clumps, with a comparative scarcity of 5′—7′ girth trees, and a serious dearth of poles and saplings. Also, in most cases, these smaller class teak trees, when present, were being interfered with and seriously injured by the growth of much inferior species. The girdling officer goes into the compartment, selects almost all these large over-mature teak trees and some small unsound ones, which are exhibiting signs of deterioration in the immediate future, and gets them girdled. This is quite right, but, as far as the writer's experience has extended, in most cases *nothing more is done to improve and help the teak crop left in the compartment*, which has thus, by the girdling operation, been seriously impoverished by the removal of hundreds of the most valuable species in it. During the many times he has done girdling, the writer has seen, over and over again, instances of fine healthy young teak poles and saplings absolutely crying out to be freed from the interfering overgrowth of some useless or less valuable species. The working plans for these forests have, it must be admitted, prescribed Improvement fellings but, as far as the writer is aware, these have never been systematically carried out.

To show the amount of Improvement fellings which have taken place in the Pyinmana Forest Division, the following figures have been taken from the Forest Administration Reports :—

Year.	Area worked over.	By whom.	Total cost.	Average cost per acre.	REMARKS.
	Acres.		Rs.	Rs. a. p.	
1912-13 ...	1,035	Division	122	0 2 0	Figures before the year 1912-13 are not available.
1913-14 ...	160	School	...	...	
1914-15 ...	2,473	Division	2,728	1 2 0	
	180	School	...	...	
1915-16 ...	800	Division	314	6 0	
	30	School	...	...	
Total for 4 years...	4,678	...	3,164	...	An average of 1,169 acres at a cost of annas 11 per acre.

It will thus be seen that, on an average, for the last four years, Improvement fellings have been carried out over an area of 1,169 acres (equal to about 1½ compartments), whereas the total area of reserves in the whole Pyinmana Forest Division amounts to 902,531 acres. The area girdled over yearly is not available from the Forest Administration Reports and therefore no comparison can be made. In the Pyinmana Forest Division, however, it may be taken within very safe limits to say that, on an average, the area girdled over yearly has been fifteen times that over which Improvement fellings have taken place. That there are other forest divisions in Burma in which the work of Improvement fellings has been as sadly neglected, is apparent from the remarks made in the last Forest Administration Report 1915-16, that in the Ruby Mines and Pegu Forest Divisions there were arrears amounting to 42,290 and 38,783 acres respectively. These forests appear, therefore, to be worked solely for the revenue derived from the girdlings, and no adequate steps are being taken to improve the remaining teak crop, deplorably

deficient as it is in the smaller age-classes. This omission may be due to the lack of funds, but it appears to be a very short-sighted policy, as when the next felling rotation comes round to these areas once again, there is bound to be a very serious falling off in revenue. In the writer's opinion, therefore, " O " improvement fellings are as essential for the satisfactory working of the teak forests in Burma as the main Selection fellings, and he now ventures to suggest that *both these operations be done at the same time by the same officer.*

The advantages of this suggestion appear to be as follows :—

(*a*) The girdling officer is usually a highly paid official and, therefore, if the Improvement fellings be supervised by him, they will be better done.

(*b*) There will be unity of method and purpose by having both these fellings done by one and the same officer.

(*c*) The area will be gone over thoroughly by the marking officer, as he will not be marking teak alone, and therefore a much better stock map, required under the present girdling rules, can be made.

(*d*) As the two fellings will be done together, and as to keep up the forest revenue in Burma girdling has to be done yearly and systematically, the concomitant " O " improvement fellings will be done annually and systematically too. This will eradicate the present *laissez-faire* policy which appears to control the Improvement fellings scheme.

The marking officer need not superintend the felling of the trees himself but can easily mark them to be felled by the subordinates working behind. Also, all those species which have a heart-wood can be girdled, and this operation can be carried out on the same lines as the girdling of teak is done at present. The disadvantages of combining both operations in one appear to be :—

(*a*) It will entail more trouble on the part of the marking officer as he will have to keep up two sets of recording registers, one for teak and one for other species,

(*b*) Extraction of the teak by the lessees will be a bit more difficult on account of the trees which have been felled in the Improvement fellings.

(*c*) It will probably cost a bit more money, inasmuch as the marking officer who, as mentioned above, is usually a highly-paid official, will have to spend more time on the area.

The disadvantages, however, are more than counterbalanced by the fact that the combined operation will ensure that the compartment will be worked as thoroughly and as completely as it should be worked, and that the crop of the future is given every chance to succeed. The terms "Selection fellings" and "Improvement fellings" are in reality more or less the same. In all silvicultural systems whatsoever, there is more or less "selection" on the part of the officer marking the trees; and also, similarly, all fellings are made by the true forester to "improve" his forest. So that there need be no difficulty as to what to call the combined operations.

3. There is another operation, which the writer has never seen done in the teak forests in which he has hitherto worked in Burma, although it is extensively practised in the Sal forests of the United Provinces, India. This is the "cutting back" operation which, though a subsidiary one, appears to be very useful. During the main fellings in any forests which are being worked, there is bound to be a certain amount of damage done to young trees of valuable species such as teak, pyinkado, padauk, etc. Further in every forest, there are a lot of young, vigorous but misshapen or forked trees of these valuable species. After the area has been worked out completely by the lessees, these broken, damaged, misshapen, or forked young trees of the more valuable species, which will never grow to anything of market value, should be cut back flush with the ground. This will admit of their stools sending up vigorous coppice shoots. Teak and pyinkado coppice freely, and this cutting back operation would be found to be exceedingly successful. Its cost, too, is surprisingly small.

4. In Burma there are now two kinds of "Improvement fellings" prescribed, "O" improvement fellings and "Y" improvement fellings. It is of the latter, which has recently been promulgated, that the writer ventures to express an opinion. "Y" improvement fellings appear to be in the nature of regeneration fellings, as they are made primarily to ensure the successful reproduction of the more valuable species. The Burma Forest School, Pyinmana, has, for the last two years, been doing these fellings and the *modus operandi* is as follows :—An area is selected, which has on it quite a fair number of young seedlings of teak, pyinkado and other valuable species. In July or August, these are pegged out by means of thin bamboo stakes about 3 feet long and the surrounding undergrowth together with the low-lying overhead cover is then removed. This method is quite correct, but a lot of time appears to be wasted in first staking out the seedlings, then clearing the shrubs, bamboos and small trees near them, and then stacking the cut débris in convenient heaps so that the seedlings may be freed. These heaps of rubbish take up collectively quite a lot of room and so hinder regeneration in those places where they are situated. They also make the areas worked over very difficult and annoying to walk over in subsequent years.

In the writer's opinion the "Y" improvement fellings may, perhaps, be done as follows as an alternative to the present method. In December of the preceding year, after selecting the area to be worked over, all the useless shrubs, bamboos and trees with low-spreading crowns such as Gyo (*Schleichera trijuga*) and Thitpagan (*Milletia Brandisiana*) found on it, should be cut down and left to dry *in situ*, no attention at all being paid to the seedlings. This work can be done under the supervision of a forest guard ; and the writer has estimated from the work done by taungya cutters in this division, that it will not cost more than Rs. 5 per acre. At the end of February or the beginning of March of the following year, the area should be completely burnt. In June or July of the same year, the pegging out of, and clearing around, valuable seedlings by a small

gang of coolies under a trained officer can be done and, at the same time, any large trees which are found hindering the young growth, but which were left standing by the forest guard who did the preliminary work, can be removed, and any stunted or misshapen saplings of valuable species, be cut back. This, together with the burning, will not cost more than Rs. 2 per acre. The total cost of the fellings for the first year will, therefore, be not more than Rs. 7 per acre and, taking the cost of the usual weedings for the subsequent four years at Re. 1 per annum per acre, the total cost of regenerating the area worked over should not amount to more than Rs. 11 per acre. This figure is well within the Rs. 15 per acre which, it is believed, is the maximum allowed in some parts for "Y" improvement fellings. The system advocated above appears to the writer to have the following advantages :—

(*a*) No heaps of débris and refuse will be found encumbering the area.

(*b*) The time to be spent on the operations by the trained, and therefore more highly-paid official, will be less.

(*c*) Fire helps the regeneration in that, firstly, it appears to have a very beneficial effect on the upper layers of the soil and, secondly, it apparently excites and stimulates the growth of suppressed seedlings and saplings. Regarding the effect produced by a ground fire on the soil, the magnificent growth of teak in taungyas may be instanced. The writer has frequently noticed that the teak seedlings have not come up half as well in those parts of the same "ya" * which have not been burnt properly by the "ya" cutter, as they have on areas which have been thoroughly well burnt. Regarding the effect fire has on seedlings, the writer has frequently observed that in all the places in the forest, where fire has occurred, and where there have been present teak and pyinkado seedlings and saplings, these have been, in most cases, either badly scorched or killed

* "ya" = a patch of cultivation.

off entirely. But, from their root-stocks, very vigorous coppice shoots have sprouted out which, in a few months or a year's time, have more than outgrown the size of the original parent seedlings or saplings. One such teak coppice shoot measured, reached a height of 12 feet in six months, whereas the original shoot, which was killed, was only 4 feet high. Pyinkado too has been found to do almost as well as teak in this respect. These teak and pyinkado saplings and seedlings appear to have been suppressed and stunted for such a length of time by the overhead cover that, even when they are freed and light is let in, they do not respond much to the benefits conferred on them. They appear to have become sluggish, and fire, although it may injure or kill off the original shoot, stimulates and excites their latent growing power. Here also it is suggested that at the time of staking out the area, if any portions of the forest, suitable for the good growth of teak and pyinkado, are found bereft of any regeneration of these two valuable species, broadcast sowing of seeds of these species may be resorted to with advantage. At Monhnit in this Division a small portion of a "ya" after burning was sown broadcast, instead of being dibbled in 6′ × 6′, as is usually done, and as was done that year in the remainder of the "ya." The teak sown broadcast has come up splendidly and is just as good as the rest of the growth in the "ya." Broadcast sowing is very cheap and corresponds most to natural sowing. It may be contended that weedings and thinnings are very difficult in areas sown broadcast, but as the rest of the "Y" improvement fellings area will have been naturally (and therefore broadcast) sown, the weedings and thinnings need not be any more difficult or expensive in the former than in the latter.

5. In Burma at present teak is worked by Government in a few divisions and by lessees in most forests. It is with regard to the latter agency that the writer ventures a suggestion. The present system for working is that the timber firm, whose tender is accepted, pays so much a ton for first class timber, so much a ton for undersized timber and so much a ton for refuse. These rates of course vary in different localities. The lessees, at the proper time, are allowed to enter the areas, which have been previously girdled over by a forest official, fell the trees so girdled, and extract in logs what they think marketable. It is only when these logs reach a measuring station that they are measured up and assessed for duty. This system appears to the writer to have two main faults. The first is that the lessees' working has to be inspected every now and then by some forest officer to see that no wastage, on which Government gets no duty, is left in the forests. The Government officials naturally want extracted every cubic foot of sound timber, which they think marketable, so that duty may be obtained on it. On the other hand, the timber firms are very reluctant to take out what they consider will not pay them to extract. These inspections, therefore, result in a conflict of opinions, and are apt to cause some hot and unpleasant discussions and to entail much subsequent correspondence between Government and the firms. The second fault is that at the measuring station too, there is apt to be a good deal of contention and hot arguments on the questions of refuse logs and allowances on partly sound ones. Here too the forest man rightly wants to pull in as much revenue as he can for Government, whereas the timber assistants with the interests of their firms at heart, want to pay in as little as they honestly can. Instead of the present system, the writer suggests that timber firms should, in future, be asked to pay a large felling rate per tree girdled plus a nominal duty per ton measured. The former can vary according to locality and other circumstances, but the latter should remain fixed. The many large timber firms in Burma must know from their past work, or on inspection by an experienced assistant can easily tell in an area, how many tons on an average can be

obtained per tree and can, with the help of the Working Plans Officer's figures, tender accordingly. To give an example, say, from a certain reserve it has been estimated that an average teak tree will give two tons of timber. Assuming the present rate of duty at Rs. 35 per ton, this would mean, according to the system now in vogue, a duty to Government of Rs. 70 per tree. Well, let the firm pay a felling rate of Rs. 50 per tree for all those girdled and marked with the "Yield" and "M" hammers, plus a duty of Rs. 10 per ton on all logs measured. The latter will be assessed as usual at a measuring station. It will thus be seen that Government will not lose anything by the transaction and the advantages of the system appear to be manifold, as shown below:—

(*a*) It will not pay the firms to leave any waste in the forest, as they will have paid something for what they have felled.

(*b*) Discussions and ensuing correspondence at the times of inspection and measurement between Government and the firms will be avoided or at least much reduced.

(*c*) Government will, in reality, get more revenue, as even if some logs are lost in transit from the reserve to the measuring station, the forest department will have already recovered part of its dues in the felling fees.

(*d*) Government will get in its revenue much sooner than at present. This is a great consideration as a good many logs take 2—5 years and sometimes longer to reach the measuring station.

The only disadvantage is that there is apt to be some differences of opinion during the girdling operations between the girdling officer and the firm's representative. This, however, could also be avoided, if the firms be made to understand that the felling rate, they tender, will have to be per average tree *of all trees girdled* (except "S. Y. L." trees). They will then not have any say in the matter at all when the girdling is being done. It may also be found difficult at first to fix the amount of felling fee for

any forest, but if all the timber firms in Rangoon be asked to tender for the working of that particular area, there is bound to be competition, and a fairly correct estimate of what the felling rate should be can be thus obtained. It does not appear that there should be any more difficulty in fixing the felling rate, as in deciding upon the amount of duty to be paid in a certain area for first class teak logs as is at present done.

NOTE.—S. Y. L. trees are those which will not yield marketable timber now or in the future and are removed for silvicultural reasons, *i.e.*, to benefit existing advance growth.

A FUNGUS ATTACK ON THE DEODAR.

BY H. M. GLOVER, I.F.S.

A root fungus, which has not, I believe, been identified as yet, is doing much damage to young deodar woods under regeneration in the drier regions of the Bashahr Division. So far as is known, it is not found where there is a considerable rainfall. Plants up to about 10 feet in height are attacked and those which have grown in the shade appear to succumb first.

The plants attacked are characterized by their very patchy appearance, needles generally on the lower branches first turning brown and dying, after which the other branches are unevenly attacked. Sometimes branches higher up the stem are attacked first, patches of green, dying and dead needles being intermixed. (*Vide* Plate 26.)

Sometimes the plant throws off the attack and large saplings are found with their lower branches killed and otherwise appear healthy, but more often the seedlings and saplings are killed outright.

If the roots are carefully examined, a yellowish-white mycelium is seen that would appear to indicate that the fungus attacks the deodar through its roots.

Up to the present, the only attempt to eradicate this fungus has been made by cutting out diseased specimens, but the result is not satisfactory. Probably the rapid lightening of the overhead

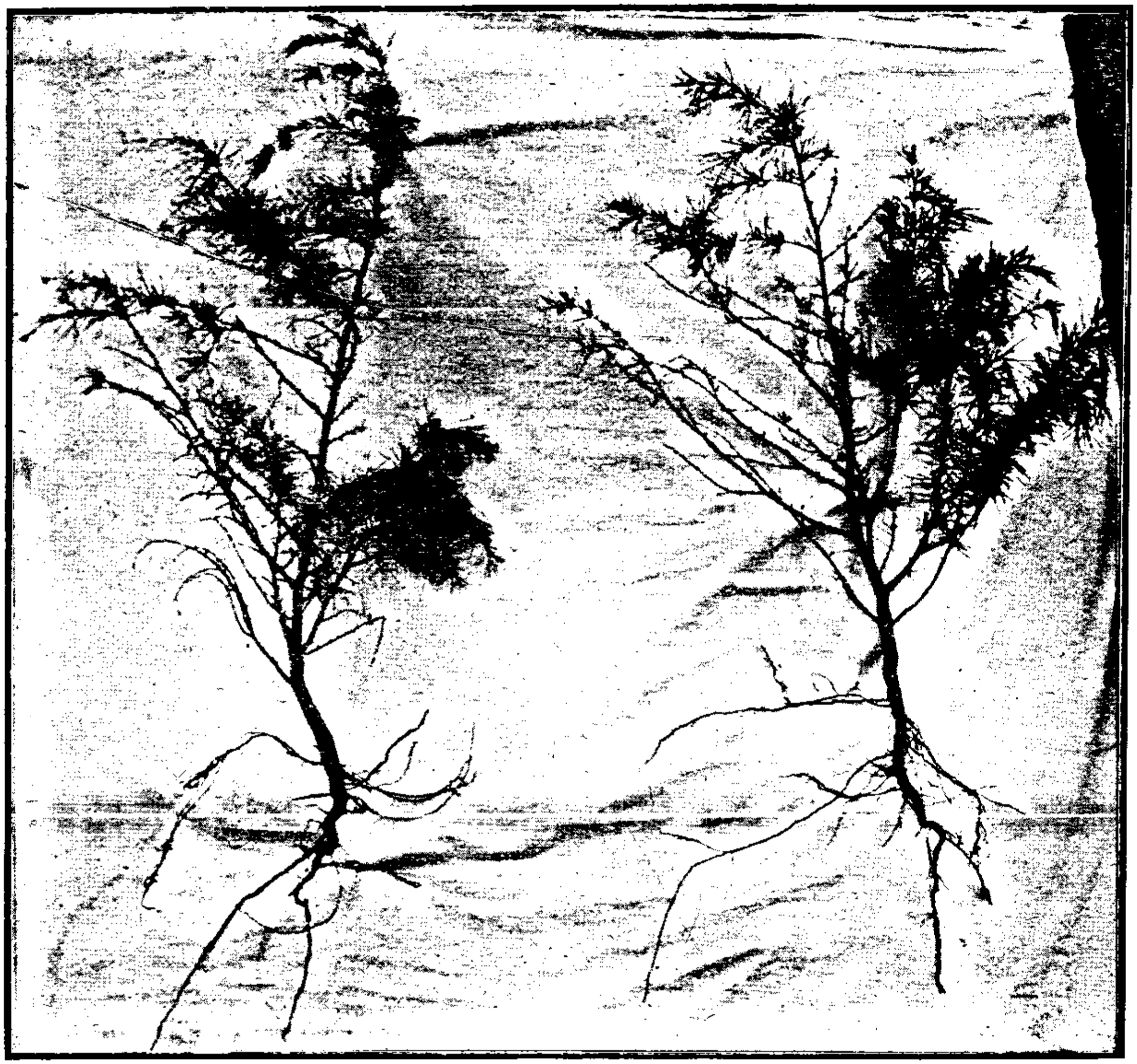

Photo.-Mechl. Dept., Thomason College, Roorkee.

A FUNGUS ATTACK ON THE DEODAR.

cover, in order to allow the young deodar to develop in the most suitable conditions, will help to get rid of the fungus, which threatens to do the greatest damage in compact blocks of regeneration, *e.g.*, those obtained after the regular regeneration fellings of 1905—07.

TROUT CULTURE IN KUMAON.

BY E. A. SMYTHIES, I.F.S.

In September 1910, an article was published in the *Indian Forester*, giving an account of the initiation and start of an experiment to introduce English brown trout (*Salmo fario*) into the lakes and rivers of Kumaon. It may not be without interest to record the subsequent development during the past seven years, the vicissitudes we have experienced, the difficulties overcome, and the success attained.

The objects of the experiment were: first, to ascertain if trout would thrive and breed in Kumaon; secondly, to raise a stock of breeding fish at the hatchery so as to have a plentiful supply of ova and fry for distribution; and thirdly, to stock or try to stock any suitable streams, rivers and lakes in the neighbourhood. A reference to the previous article will show that the trout hatchery was located in a very suitable spot near Bhowali, and about eight miles from Naini Tal, that the first consignment of 30,000 ova was received from Kashmir early in 1910, and hatching was very successful. We will now record subsequent results.

In 1910.—Altogether about 8,000 fry were put out in Naini Tal lake, Sath Tal lake, and various streams near by, in September, while 2,000 fry were kept in the hatchery for subsequent breeding purposes.

Unfortunately, an enormous flood (resulting from 25 inches of rain in 2½ days) early in October caused great destruction in the streams, and the fry put out were never seen again.

In 1911.—It was not possible to do anything except to look after the yearlings in the hatchery-ponds.

In 1912.—A further consignment of 30,000 ova was received from Kashmir. These also hatched out very well indeed, and about 9,000 fry were put out in Naini Tal, Naukutchia Tal and various streams. In the Naini lake, the original 1910 fry had flourished and it is recorded that several 1½ lb. fish had been landed. It is also recorded that villagers were busily netting out the small trout 5" to 7" long from streams outside the forest reserves, and from that time no further attempt has been made to stock these streams.

In 1913.—There were 60 three-year old fish in the hatchery and 500 yearlings. The 3-year old fish produced good fertile ova, which was successfully hatched out. This was very interesting as solving the question whether trout would breed in Kumaon. Unfortunately, while the fry were still in the hatching boxes, one night the pipe supplying water became blocked up with leaves, and in the morning all the little fry were found dead.

In 1914.—We obtained 12,000 ova from the stock, from which 3,500 healthy fry were successfully reared, and partly distributed amongst the surrounding lakes and streams. A considerable number of the older fish were attacked by a growth in the gills (Carcinoma of the thyroid gland) and died. Specimens of diseased fish were sent to Mr. Southwell, Director of Fisheries, Bengal.

In 1915.—The attack of carcinoma continued very severely and did considerable harm. Mr. Southwell's report was received during the year, and he described the disease, and suggested remedial measures to check it. Very fortunately, his invaluable suggestions proved most successful and, by the end of the year, the disease was practically stamped out. It had, however, made great inroads into the stock of breeding fish, and threw back the development of the hatchery. However, 15,000 ova were obtained, from which 7,000 fry were hatched out. Of these 600 were kept for stock, and the rest put out in lakes and streams.

In 1916.—We had another rather disappointing year. Of the 1910 and 1912 hatching there were only 43 fish left, while the ova from the 2-year olds mostly went bad for some unknown reason. However, about 9,000 fry were obtained.

In 1917.—We have had an excellent year. The stock of breeding fish in the hatchery is as follows :—

Of 1910 hatching— 1 (about 6 lbs.).
„ 1912 „ — 38 (from $2\frac{1}{2}$ to $4\frac{1}{2}$ lbs.).
„ 1914 „ —196 (from 1 to 2 lbs.).
„ 1915 „ —246 (from 6 oz. to 12 oz.).
„ *1916* „ *(yearlings)—198.*

The ova was obtained in very good condition, and about 50,000 being obtained, of which 12,000 were sent to Tehri-Garhwal,* where another trout hatchery is being started to try and stock the upper waters of the Bhagirathi and Ganges system. About 7,000 small fry were put out in April shortly after hatching, and another 7,000 will be put out after the monsoon. Let us refer to the objects of the experiment and gauge the extent of the success achieved. First to ascertain if trout would thrive and breed in Kumaon. This is fully demonstrated. Secondly, to raise a stock of breeding fish at the Hatchery. The Hatchery is now in a most flourishing condition. It is entirely self-supporting, and with a good stock of young fish kept for breeding purposes, at least 50,000 ova a year are expected in the future.

Thirdly, to try and stock any suitable streams, rivers and lakes in the vicinity. Here the results obtained to date have been rather disappointing, the lack of greater success has not been due to any errors of management, but rather to the unfavourable conditions of the local rivers and lakes. Of the five larger Kumaun lakes, four (*i.e.*, Bhim Tal, Sath Tal, Naukutchia Tal and Malwa Tal) are all too hot for trout. Temperature readings have shown that they all go over 73° F. in the hot weather, and never go down to 48° F. in the cold weather (the necessary temperature for breeding). In Naini Tal, the conditions for development are favourable, and very fine trout have been caught (on atta). A fish of 4 lbs. is well authenticated, while there are circumstantial rumours of trout caught by native fishermen in the cold weather up to 8 and 9 lbs., but these are not really certain. However, the condition for spawning

* This consignment of ova, the first sent from the hatchery, arrived in excellent condition, and hatched out most successfully. This is very encouraging.

in Naini lake are almost hopeless, as there are no gravel beds, and no stream running in during the cold weather, and it is difficult to see how trout can propagate themselves. As regards the rivers, the Kosi, the Ramganga, the Gaula and their tributaries, these are all far too hot for trout, except in their uppermost reaches, where they take on the character of hill streams, and there the fish only develop into burn trout. We have to date put out about 28,000 fry and yearlings and 2-year olds, but there is not very much to show for it.

The principal object of future management of the hatchery will, therefore, be to provide ova in large quantities for stocking the snow-fed waters of Tehri, of British Garhwal, and of Almora. This will probably lead to better results than attempting to stock the local rivers and lakes. This is a rather more ambitious scheme than the ideas first held, when the Hatchery was started nearly eight years ago, but the success obtained this year in despatching ova gives every confidence for the future. The further introduction of brown trout into Naini lake and the best of the local streams will, however, not be altogether abandoned, but surplus fry, yearlings, and 2-year olds (*i.e.*, beyond the requirements of the Hatchery for breeding purposes) will be put out from time to time.

As an indication of the scope of future action, it may be mentioned—given good breeding conditions—that large consignments of ova will, we hope, be sent in the coming cold weather to Tehri State, to the Gonah lake in upper Garhwal (on the Bireh Ganga), and the Eastern Ramganga (above Tejam) in Almora district, where the rivers are snow-fed. With a plentiful supply of ova which is now, barring accidents, fairly assured, the prospects for the future are excellent, but it will be three or four years before we shall know definitely what success has been achieved in the larger snow-fed rivers.

ANACOLOSA DENSIFLORA.

BY P. M. LUSHINGTON, I.F.S.

In his description of this evergreen tree Bourdillon has not been far wide of the mark when he says it is " A lofty straight-stemmed tree. Height 90 feet. Diameter 2 feet." There is little doubt that the tree grows considerably higher, as specimens were observed of at least 120 feet with an absolutely straight bole of not less than half the height. Bourdillon goes on to say: "as yet found only on the Anamallays outside our limits." This tree is evidently, by no means, uncommon in Tinnevelly; for, we have recently observed it both at Kodamadi at an elevation of 1,500 feet and at Kannikatti, which is 1,000 feet higher. At both elevations, it is found in the dense evergreen and is known by the name *Kal Manikkam*. It can be recognized by the non-botanical person by its habit of shedding pieces of bark rather like the Plane tree.

At Kannikatti there is an area of one acre which has been cleared of undergrowth and opened up to promote the regeneration of the better species. Incidentally I may mention that the enumeration of this plot showed that the timber on it, exclusive of branchwood, amounted to no less than 103 tons per acre. At the corner of this patch we found two of these trees of 4 feet, and 4 feet 4 inches girth with the usual straight long bole. Close alongside was a small sapling of about 9 inches girth and, on this, operations were commenced to see if this giant-like tree was like his *confrères* of the *Olacaceæa* root-parasite. There was little doubt from the start of these operations that he partook of the nature of the root-parasite, for numerous surface roots were quickly apparent and after five minutes' digging the first connection was found, a connection between two separate roots of the tree. Subsequent digging showed that this giant parasite has giant haustoria, the largest found being 3″ × 1½′ but there were many not far short of this. There appears to be a singular similarity between the habit of this parasite and that of the *Ximenia americana* found on the Javadi hills. The likeness is not so much in the actual haustoria (for these are much rounder

and smooth), as in the habit of the haustoria forming directly from the root, without the small attachment which is seen in the Sandal and Olax. These immense haustoria at times seem to clasp each other and form a complete fusion of root, exactly in the same way as the *Ximenia*. It is hard to say what is the object of this excessive cannibalism that goes on in both these genera, but a day's digging produced 20 haustoria, out of which only one was parasiting on another plant. In this case the host was *Diospyros Orixensis*. The specimens are being sent to the Coimbatore Museum and, as I believe, the root-parasatism of this species has not been worked out, they may be of interest to Dr. Barber and other botanists interested in parasitism. Doubtless, fresh specimens can be obtained from the localities indicated above.

REPORT ON THE LEVELLING CARRIED OUT TO ASCERTAIN THE MOTION, IF ANY, OF BENCH-MARKS FIXED TO TREES IN THE COMPOUND OF THE TRIGONOMETRICAL SURVEY OFFICE, DEHRA DUN, DURING THE PERIOD APRIL 1914 TO APRIL 1917.

BY COL. G. P. LENOX-CONYNGHAM, R.E., SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY, DEHRA DUN.

The line of levels formed a small circuit starting from, and closing upon, the G. T. S. Standard Bench-mark in the above compound. The levelling was done twice yearly, once in April and once in October, before and after the monsoons, *i.e.*, just before and after the period of greatest vegetative activity.

Ten trees of different kinds and ages were selected on which bench-marks consisting of zinc plates bearing the inscription $\frac{\text{G. T. S.}}{\text{B. M.}}$ (with —⊖— between) were nailed, the horizontal line through the circle being the point of reference.

The bench-marks were numbered serially from 1 to 24 and the numbers were stamped on the zinc plates. 18 of these zinc-plate-bench-marks were fixed vertically on the trunks of the trees

at heights varying from 9 inches to 6 feet above ground, some on the bark and some on the sap-wood after removing the bark. Three were fixed horizontally to the heart-wood in large nicks cut in buttresses near the base of the trunk; two were fixed horizontally on the root of a rubber tree, and one on that of a teak tree.

The ten trees to which bench-marks have been fixed are:—

(*a*) Large Tun tree	...	Bench-marks	10, 11 and 23.
(*b*) Small Tun tree	...	Do.	19 and 20.
(*c*) Large Shisham tree	...	Do.	17 and 18.
(*d*) Small Shisham tree	...	Do.	3.
(*e*) Large Chir tree	...	Do.	5, 6 and 21.
(*f*) Small Chir tree	...	Do.	4.
(*g*) Large Gamhar tree (*Gmelina arborea*).		Do.	7, 8 and 9.
(*h*) Large Teak tree	...	Do.	12, 13, 14 and 24.
(*i*) Large Rubber tree (*Ficus elastica*)		Do.	1 and 2.
(*j*) Small Silver Oak (*Grevillea robusta.*)		Do.	15 and 16.

These levelling operations have been carried out at the request of the Forest Department in order to decide whether the stems of trees rise bodily during the process of growth.

From the results given in the table attached it will be seen that, during this period, there has been no appreciable change in the constancy of the elevation of the bench-marks in question. From the effects on, and the conditions of, the bench-marks nailed to the bark or to the sap-wood of the trees there is evidence of the growth in the girth of the trees, for several of the zinc plates were actually forced over the heads of the nails and were found lying on the ground, and most of the remainder have become distorted, owing to strain caused by this growth.

Those bench-marks which are fixed vertically cannot be connected by direct levelling, that is to say, the levelling staff cannot be placed directly on the bench-mark. In such cases a peg was driven into the ground as near the bench-mark as possible and

the staff was placed on that, then the vertical distance from the top of the peg to the horizontal line on the zinc plate was measured with a tape.

The small discrepancies shown in the table may be in part due to errors in the tape measurements which were, in some instances, rather difficult to make. The results of the levelling to the horizontal bench-marks, on which the staff could be erected, show scarcely any changes at all during the three years that the work has been going on.

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TABLE OF RESULTS.

No. of Bench-Mark.	Description of Bench-Mark.	How fixed.	Height above ground *feet*.	Height in feet above (+) or below (−) the Standard Bench-Mark near the Office of the Superintendent of the Trigonometrical Survey. Date. April 1914.	October 1914.	April 1915.	October 1915.	May 1916.	October 1916.	April 1917.	Remarks. (May 1917.)
10	Large Tun tree.	Vertically on bark.	4¾	+4·189	+4·199	+4·180	...	...	...	...	Forced over the heads of the nails.
11		Vertically on sap-wood.	4	+3·589	+3·567	+3·606	...	...	...	...	Ditto.
23		Horizontally to heart-wood.	¾	+0·585	+0·581	+0·581	+0·583	+0·581	+0·584	−·036″ +0·582	In good condition. Connected by direct levelling.
7	Large Gambhar tree (*Gmelina arborea*).	Vertically on bark.	4¾	+6·959	+6·932	+6·964	+6·947	+6·959	+6·958	−·024″ +6·957	Bent and being forced out. Connected by tape measurements.
9		Vertically on sap-wood.	3½	+5·739	+5·702	+5·730	+5·708	+5·720	+5·716	+5·714 −·3″	Growth of bark on right edge of plate, otherwise in good condition. Connected by tape measurements.
8		Horizontally to heart-wood.	2½	+4·750	+4·754	+4·752	+4·752	+4·758	+4·761	+4·759 +·08″	In good condition. Connected by direct levelling.

No. of Bench-Mark.	Description of Bench-Mark.	How fixed.	Height above ground feet.	Height in feet above (+) or below (—) the Standard Bench-Mark near the Office of the Superintendent of the Trigonomertical Survey. Date. April 1914.	October 1914.	April 1915.	October 1915.	May 1916.	October 1916.	April. 1917.	Remarks. (May 1917.)
5	Large Chir tree.	Vertically on bark.	4	+7·421	+7·412	+7·479	+7·403	+7·399	+7·407	—·26″ +7·399	In good condition. Connected by tape measurements.
6	Large Chir tree.	Vertically on sap-wood.	3	+6·246	+6·223	+6·237	+6·229	+6·228	+6·247	+6·253 +·08″	Growth of bark on right edge of plate, otherwise in good condition. Connected by tape measurements.
21	Large Chir tree.	Horizontally to heart-wood.	1¾	+4·658	+4·667	+4·663	+4·662	+4·668	+4·672	+4·667 +·1″	In good condition. Connected by direct levelling.
4	Small Chir tree.	Vertically on sap-wood.	4	+7·344	+7·317	+7·325	+7·321	+7·333	...	...	This tree was removed in 1916.
3	Small Shisham tree.	Vertically on bark.	3¾	+6·771	+6·757	+6·763	+6·745	+6·765	+6·763	+6·755 —·2″	Growth of bark on both edges of plate, which is bent. Connected by tape measurements.
1	Large Rubber tree (*Ficus elastica*).	Horizontally on sap-wood of root.	1½	+6·105	+6·128	+6·120	+6·120	+6·126	+6·144	+6·118 +·15″	Growth of bark on all sides of the plate, which is bent and not horizontal. Connected by direct levelling.
2	Large Rubber tree (*Ficus elastica*).	Horizontally on bark of root.	¾	+5·192	+5·219	+5·212	+5·206	+5·201	+5·212	+5·204 +·14″	Ditto.

19	Small Tun tree.	Vertically on bark.	5	+6·481	+6·477	+6·508	+6·492	+6·503	+6·510	+6·523 +·5″	The plate, which is bent, is sticking only ¼ inch out of the tree at its right edge and the nail on this side has been forced out. Connected by tape measurements.
20		Vertically on sap-wood.	4½	+5·977	+5·971	+5·979	...	...	...	...	Forced over the heads of the nails.
22	Large Shisham tree.	Horizontally to heart-wood.	2½	+4·448	+4·457	+4·459	+4·455	+4·459	+4·466	+·14″ +4·460	In good condition. Connected by direct levelling.
17		Vertically on bark.	6	+7·647	+7·659	+7·613	+7·640	+7·648	+7·647	+7·657 +·24″	In good condition. Connected by tape measurements.
18		Vertically on sap-wood.	4½	+6·276	+6·268	+6·287	+6·279	+6·288	+6·276	+6·271 —·06″	Bent and being forced out particularly at the left edge which is not quite against the tree. Connected by tape measurements.
15	Small Silver Oak (*Grevillea robusta*).	Vertically on bark.	3⅜	+1·981	+1·986	+1·995	+1·985	+1·988	+1·994	+1·981 ·0	Growth of bark on both edges of plate, which is bent. Connected by tape measurements.
16		Vertically on sap-wood.	3½	+1·433	+1·432	+1·442	+1·438	+1·436	+1·448	+1·435 +·02	Ditto.
14	Large Teak tree.	Horizontally on bark of root.	¾	—3·481	—3·464	—3·463	...	...	...	...	Forced out.
24		Horizontally to heart-wood.	1¼	—3·092	—3·086	—3·084	—3·096	—3·097	—3·091	+·05″ —3·096	In good condition. Connected by direct levelling.
12		Vertically on bark.	5¼	+1·285	+1·284	+1·229	+1·259	+1·264	+1·252	+1·260 —·3″	Bent a little. Connected by tape measurements.
13		Vertically on sap-wood.	5	+0·975	+0·988	+0·974	+0·954	+0·949	+0·948	+0·955 —·24″	Ditto.

EXTRACTS.

THE COMMERCIAL SIDE OF INDIAN FORESTRY.

The receipt of the proceedings of the Royal Society of Arts containing the discussion on Mr. Pearson's Paper on "The Recent Industrial and Economic Development of Indian Forest Products," affords us a ground for returning to that paper which had already been dealt with in our issue of 2nd June. We had some little time back expressed a hope that Mr. Pearson would one day be asked to put the case for the Indian Forest Department before the British public through the Royal Society of Arts and we are glad to see that this step has been taken at a time when industrial questions both at Home and in India are being discussed with a seriousness they never commanded before. It is often the discussion upon a subject put before a British Society that has the more telling effect; the lecturer puts his case, and perhaps if he is an official feels himself under some restraint while doing so, since when there is a policy to be opposed, as there undoubtedly is in the case of the Indian Forest Department, it scarcely becomes one of the prominent officers of the service concerned to get on a public platform and condemn it root and branch. The best he can do is to indicate temperately where it may with advantage be modified and then leave it to such hearers who are qualified to speak on the subject to drive his suggestions home as hard as they may, knowing that in doing so they are infringing no codes of service etiquette. The first speaker taking part in the discussion was of course the Chairman, Sir Robert Carlyle, who, from his long connection with the Indian Forest Service, was able to speak with inside knowledge of it. He confirmed what we have for year said of Indian forests when he remarked that—"outside the Agricultural Department he could see nothing in India comparable to forests as a potential source of revenue"; and again when he said—"he could not understand why the Government should not borrow capital to open up and and develop the forests." It was

a forester himself who, as far as we know, was the first to raise the question of Forest Loans in the *Indian Forester* of July 1912; and being struck with the value of the idea we strongly supported it in our issue of 5th October of that year and have since then from time to time urged a consideration of this policy. In advocating it Sir Robert has urged the same reasons which we have from time to time put forward. He said—"No businessman would ever dream of developing a large business by starting in a small way, and setting aside year by year a small portion of his revenue towards extending it. He would either invest his own capital, or, if he had not capital, borrow it; and he had never yet been able to see why the Government of India should be in a different position in that respect from the businessman." Remarks such as these coming from a weighty quarter are commended to the Indian Industries Commission when that body is resuscitated And granted that capital is raised and our future Forest Department is worked on the same lines as our Railways and Canals, how is the capital to be employed? We do not think it should be devoted to the establishment of huge monopolies in all parts of the country, but on the contrary to the opening out merely of demonstration factories leaving private enterprise to duplicate them after it has been made clear that the ventures are sound ones. But there will be no use whatever in going even so far before roads have been made and means of mechanical extraction established. When this has been done and the experimental factories established, the Forest Department can look to educating Railways into preserving their own sleepers, to paper-makers to making their own pulp and to industrialists of sorts to running their own turpentine and rosin factories, etc.

That the Indian Forest Department has hitherto been starved admits of no doubt, but that it is run on less scientific lines than Departments in America and Japan, as one speaker held, does not seem to us at all likely. Nowhere has the outcry against timber waste been greater than in America, and anything like a forest policy has only very recently come into existence there. It may be that before timber is cut in the forests of America a

highly experienced forest engineer surveys it and gets out exact costs in regard to waterways, light railways, and other means of transport, and makes out an estimate of the timber available and its cost of extraction. But this is no more than the Forest Department in India does under its policy of rotations and markings and working-plans generally. Extraction in India at present is mostly by human and animal power because they are so cheap, but mechanical power is being gradually introduced where it is found to pay. Nor do we advocate the unlimited increase of forest staff from Home; forest education in India should be improved and the staff expanded to any degree desirable from the indigenous outturn of forest schools. Unfortunately, though the human material is at hand for expansion there is a lamentable lack of at least one industrial product needed for developing forest products, this is—chemicals, the great bulk of which have to be imported from Europe and cost so much landed in India as to make profitable working of the forest products difficult. Attention has, therefore, also to be directed to the manufacture of such chemicals in India as a preliminary to the expansion of forest industries. To give only one instance from Mr. Pearson's Paper—" Any person with the most rudimentary knowledge of treating timber might with justice criticize the necessity for adopting such systems of treatment as mixing chloride of zinc with small quantities of creosote, or again, why creosote should be mixed with petroleum oils. The answer is that all creosote has to be imported and costs about 1*s.* 4*d.* per gallon at a treating plant in India, so that every effort is to be made to reduce the cost of the antiseptic. A good grade of creosote has recently been produced in India, but at a relatively high price, which, however, can no doubt be reduced. As soon as a good grade of coal-tar creosote is obtainable in India at a reasonable figure, it is anticipated that the antiseptic treatment of timber will advance by leaps and bounds, while a new industry will come into existence by the manufacture of creosote." The high cost of chemicals has undoubtedly retarded the development of the paper-pulp industry, so much so that the production of

mechanical pulp is being undertaken, at least in the Punjab where a concession has been granted to exploit silver fir and spruce in Kulu and Bashahr. Mr. Smeeton, the concessionaire, intends to fell 20,000 trees a year and float them down the Beas and Sutlej to a point where he can take 8,000 h. p. from a canal, and there manufacture 18,000 tons of mechanical wood-pulp per annum. He intends also to manufacture paper, matches and tea-boxes. The success of mechanical pulp manufacture in India will also depend after all on the price of chemicals If these can be made in India and sold cheap, then chemical pulp produced from bamboo and grasses will be more cheaply made than mechanical pulp. Moreover, in any case, at the present time the carriage of timber from forest to factory will be a great handicap on the industry except where it can be effected by cheap water carriage, that is, when both factory and timber are close to a stream down which the timber can be floated.

Some remarks made by Sir Louis Dane, late Lieutenant-Governor of the Punjab, give us an insight into a few of the artificial causes hampering enterprise in India. He tells us if it was found when a proposed concession was examined by the Finance Department of the Government of India that the concessionaire made more than 6 per cent. he was told that it was not to the best interests of India. No mercantile man will accept such an obstructive doctrine, it is he who takes the risks and he would be foolish to embark on an enterprise with so narrow a margin of profit. Sir Louis himself apparently thinks very differently, to judge from the extent to which he helped Mr. Smeeton to start his enterprise, as this gentleman himself acknowledges. It would be a good thing for India if some of its high officials who make such revelations after leaving the country had been permitted to make them while in it.—[*Indian Engineering*.]

THE CASE FOR THE WOODPECKER!

"What good is the woodpecker?" Letters reach the Canadian Forestry Journal asking this question and in many cases proceeding to answer it with threats of extermination for all woodpeckers seen about the correspondent's property.

It would appear that only the Yellow-bellied Sapsucker should be regarded as detrimental to tree life, and that all other varieties are to be encouraged. The following article by Dr. Gordon Hewitt, Dominion Entomologist, will be found of value:

WOODPECKERS AS INSECT DESTROYERS.

A Canadian bank manager recently boasted that he had shot seven woodpeckers in succession in his orchard, evidently under the impression that he was performing an exceedingly meritorious service to the community. He was destroying one of our most active insectivorous birds and, though keenly interested in the conservation of his trees and of our forests, he was destroying a most useful ally in their preservation. Boring insects are deadly pests of trees, and woodpeckers are their special enemies, as they are able to reach these pests so secure from other enemies. No birds are more useful in the protection of our forests.

With the exception of the Sapsuckers, our woodpeckers rarely attack healthy trees and are among the most beneficial of our insect-destroying birds. The Yellow-bellied Sapsucker has a black patch on its breast, while the top of the head from the base of the bill is red. These marks distinguish it from all other woodpeckers. It girdles the trees with holes in securing the sap which forms part of its food.

The different species of woodpeckers are the most important enemies of the bark-beetles and timber-boring beetles, these being the chief enemies of our forest and other trees. About seventy-five per cent. of their total food is animal food and this consists chiefly of insects, among which the wood-boring beetles predominate. The Common Flicker is a great destroyer of ants, particularly on lawns, as many as 5,000 ants having been found in the stomach

of a single bird. The little Downy Woodpecker and Flicker should be encouraged to come into gardens. They will readily accept nesting-boxes and the encouragement of these birds is the best insurance policy that the tree-lover can take out.—[*Canadian Forestry Journal.*]

[We are not aware that any Indian woodpecker has up-to-date been convicted of Sap-sucking. It has, however, been suggested by Mr. A. E. Osmaston (*vide* Bombay Natural History Society Journal, Vol. XXIV, pp. 363—366), that the well-known horizontal lines of small holes, so common on the trunks of various trees in the Himalayas, are made by woodpeckers with a view to feeding on the sap.

This would seem to be the most plausible explanation of this curious phenomenon. The woodpecker mainly responsible for this in the Himalayas is probably *Dendrocopus himalayensis* (the Pied Himalayan Woodpecker) but *Hypopicus hyperythrus* (the Chestnut-bellied Pied Woodpecker) and *Dendrocopus auriceps* (the Brown-fronted Pied Woodpecker) are also strongly suspected.

None of these species, so far as we are aware, has been actually observed making the holes, but they are undoubtedly the work of a woodpecker and from their extreme commonness we are inclined to attribute them mainly to the very common Pied Himalayan Woodpecker —HON. ED.]

CAMPHOR PRODUCTION IN FORMOSA.

The output of camphor in Formosa during the year 1917 is estimated to reach the total of 11,616,000 lbs. It is a matter of considerable uncertainty whether the price of camphor in the world's markets is actually on the upward grade, or whether the present high prices are due entirely to the questions of tonnage difficulties and high insurance rates. As far as can be judged, the Japanese Government are not aiming at a higher revenue from the camphor monopoly, and transport difficulties are certainly responsible for a very considerable proportion of the increase in price which has taken place. In Formosa every precaution is being taken to encourage the planting out of young camphor trees. A very large number of such young trees have been planted during the past few years, but it will be at least thirty years before these trees will be capable of use for camphor extraction. At the same time, the older trees are steadily disappearing, and the immediate future of the camphor industry is calling for serious consideration

by the authorities. The imports of camphor from Japan into the United States has, for the last twelve months, amounted to about 500,000 lbs. per month, but for the next year this quantity will be increased to 1,000,000 lbs. Crude camphor oil has steadily increased in price, and is very firm, apparently due entirely to freight and insurance difficulties.—[*Oil and Colour Trades Journal.*]

FIFTY SHEEP POISONED.

More than fifty sheep, pastured in West Lothian, have died, it is reported, from the effect of eating the leaves of yew trees and rhododendron bushes. Many others are seriously affected.—[*The Pharmaceutical Journal & Pharmacist.*]

THE PRODUCTION OF VEGETABLE DYES IN JAPAN.

The almost world-wide shortage of artificial dyestuffs has, as everybody knows, greatly encouraged the search for vegetable dyes, and from Japan it is reported that a process is being patented by which colours other than red are obtained from the chrysanthemum, and that a company is being formed to work the patent. Another process has been invented in Japan for obtaining indigo dyes from grass which is valueless for the manufacture of manure or animal food; this process is also being patented. Quite apart from its investigations in this direction, Japan is making satisfactory progress with its national scheme for the manufacture of synthetic dyestuffs.—[*The Pharmaceutical Journal & Pharmacist.*]

THE USES OF SHELLAC.

Shellac is now being used for a variety of industrial purposes as a substitute for other materials which have become scarce. From America it is reported that shellac is being used instead of gelatin for stiffening felt hats, and it is also being used on an extensive scale as a substitute for leather; the extraordinary demand for leather for army purposes has necessitated the use of

some suitable substitute, and canvas and shellac are now being employed instead of pressed leather or stiffened leather board in the manufacture of shoe tips, especially for the cheaper qualities of shoes. Then, again, another great outlet for shellac is the manufacture of gramophone records. So great has the demand for shellac become in America since the war, that the quantity imported into that country last year was something like 65 per cent. greater than the quantity imported in 1914.—[*The Pharmaceutical Journal & Pharmacist.*]